IRON AND STEEL ENGINEER

J. F. KELLY, Editor

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Copyright, 1925, by Association of Iron and Steel Electrical Engineers.

Published Monthly by

Association of Iron and Steel Electrical Engineers

706 Empire Building, Pittsburgh, Pa.

Entered as second-class mail matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879.

Subscription Price $5.00 per Year. Single Copy 50c.

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Tech. 68

EDITORIALS

TWENTY-SECOND ANNUAL CONVENTION AND IRON AND STEEL EXPOSITION

Electrical Combustion and Safety Problems Discussed

Over five hundred Electrical, Combustion, Mechanical and Safety engineers from the Iron and Steel Industry attended the Annual Convention of the A. I. & S. E. E., held at Chicago, June 7 to 11, inclusive. About five thousand interested visitors, consisting of Presidents, General Superintendents, Works Managers, Engineers, Master Mechanics, Safety Directors attended the Iron and Steel Exposition which was one of the special features held in conjunction with the Annual Convention.

Promptly on Monday at 10:00 A. M., June 7, 1926, the Convention was opened with a business session at which time all of the various committees made their yearly reports. Mr. A. C. Cummins, Electrical Engineer, Carnegie Steel Company, Duquesne, Pa., Chairman of the Standardization Committee, presented a report in connection with the Standardization of Mill Type Motors. Mr. C. L. Baker, Management's Representative, Bethlehem Steel Company, Johnstown, Pa, Chairman of the Safety Division, presented a comprehensive report in connection with recommendations covering the rules for the Safe Operation of Electric Overhead Traveling Cranes. Mr. C. S. Proudfoot, Works Manager, U. S. Ferro Alloys Corporation, Niagara Falls, New York, Chairman of the Papers Committee, presented a report of what has been accomplished during the past year. Mr. W. S. Hall, Electrical Engineer, Illinois Steel Company, So. Chicago, Chairman of the Electrical Development Committee, spoke at some length regarding the future developments of the Electrical Art. Mr. H. C. Siebert, Combustion Engineer, Bethlehem Steel Company, Bethlehem, Pa., Chairman of the Combustion Committee, outlined what has been the developments during the past year in the combustion field. Mr. W. P. Chandler, Special Engineer, Carnegie Steel Company, Pittsburgh, Pa., Chairman of the Electric Heat Committee, presented the accomplishments of the Electric Heat Committee during the past year. Mr. James Farrington, Treasurer of the A. I. & S. E. E., presented the annual audit which was made by the Willison Audit and System Company, Certified Public Accountants. J. F. Kelly, Business Manager of the Association, presented the report covering the accomplishments of the Association for the past year.

The Safety Division, under the able leadership of C. L. Baker, Management's Representative, Bethlehem Steel Company, Johnstown, Pa., opened their session with a luncheon at 12:30, noon, which was attended by practically all of the engineers, guests and exhibitors who were in attendance at the Convention and Exposition. Dr. W. B. Fisk, Chief Surgeon of the International Harvester Company, spoke on the physical qualifications of the craneman. The major points covered in Dr. Fisk's talk were Age, Language, Lineage, Character, Education, Physical Examination and Health. Mr. Charles B. Scott, President of the National Safety Council, made a very pleasing address in which he outlined the importance of accident prevention. Mr. Scott paid a tribute to the Association of Iron and Steel Electrical Engineers relating how the National Safety Council found its origin in 1912 within the Association of Iron and Steel Electrical Engineers. President Scott's description of the workings of the National Safety Council were intensely interesting. One point Mr. Scott brought up was that you cannot control your accidents in the use of physical safeguards, but that education was one of the most important factors. He advocated careful selection of men to do electrical work, careful instruction of new men with reference to their particular work and close supervision of the men. Mr. Scott also seemed to feel that Safety Work should be a definite integral part of every operation in the Steel Plant.

Mr. A. C. Cummins, Electrical Engineer, Carnegie Steel Company, Duquesne, Pa., related his experience in connection with voltages greater than 250. Mr. Cummins presented an analysis which he made in connection with the electrical accidents and presented six primary causes. First, Electrical Shocks; second, Electric Burns; third, those Accidents which were due to failures of electrical driven machinery; fourth, Accidents that were occasioned by fires for which failure of electrical wiring or equipment were primarily responsible; fifth, Explosions in which the official ignition could be blamed on electricity, and, sixth, Lack of co-operation.

Mr. John A. Oartel, Chief of the Safety Bureau of the Carnegie Steel Company, spoke at some length about the relation between the Electrical, Combustion and Safety Divisions in the A. I. & S. E. E. Mr. Oartel also brought out the fact that the Association's interest and objects in the Safety Movement was to promote definite solutions to particular problems that exist in the Iron and Steel Industry.

Mr. Walter Greenwood, Safety Engineer, Carnegie Steel Company, Youngstown, Ohio, presented a most able paper, which will be found in the editorial columns of this issue.

Mr. F. W. Cramer, Asst. Electrical Superintendent, Bethlehem Steel Company, Johnstown, Pa., and Secretary of the A. I. & S. E. E., presented the recommendations prepared by the Association covering rules for the Safe Operation of Electric Overhead Traveling Cranes. After some discussion, a motion was offered that these rules be adopted as read and that they be made a part of the permanent records of this Association and that they also be recommended for use in all of the Iron and Steel Plants throughout the United States and Canada. Motion carried unanimously.

Monday evening, under direction of R. L. McIntosh, the members, guests and the exhibitors were

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*Electrification and Simplification—Their Effect Upon the Foundry's Future**

By L. W. EGAN†

THE Foundry Industry is the oldest of the metal working industries known to civilization and dates back to the dawn of history They made castings a couple of centuries ago that were the equal, if not superior, to some of our best castings made today in iron and bronze. The basic method of making these castings was the same as that now used, and facing sand next to the pattern was used then just as it is now. The hand ramming, which is still in existence in foundries, does not differ from that used before the time of Christ. True, we have a cupola with a motor blower and a few emery wheels that did not exist then, but you can find any number of foundries now that will show only this amount of improvement over the methods used then. We have foundries in operation today that differ from those that made the cannons for George Washington's army only in that a motor driven blower is used on the cupola.

The Industry is full of atmosphere and traditions that are hoary with age and antiquity. The whole structure is permeated with contradictory theories and methods; is redolent with obstructions, tricks, heresies and hokus-pokus.

All this is useless, and has survived this long only because the managements have been heedless to them or were unwilling to fly in the face of the arguments of their associates or their assistants out in the plants. It seemed like defying fate. They had been handed down from generation to generation and as such it was to be assumed that we should, by this time, entirely understand the action of the various factors in sand and melted metals upon the finished casting.

There are practices in use that have survived this long only because the Owners and Managers have been too busy with other affairs of business to give them the necessary thought, or to force through and support sufficient active investigation to cause their elimination.

Personal opinions of individuals in the industry, personal practices and methods sponsored and guaranteed by an individual have been the governing factors in deciding the processes in use. These practices were the result of the imperical knowledge of the individual. He is supposed to have accumulated this knowledge and information in direct practical contact with the work.

A great number of the foundrymen were conscientious in their statements and have contributed valuable work to the industry. However, it was a hard matter to integrate between the relative values of the various arguments since none of them could be reduced to a common basis for comparison. Therefore, the industry has suffered.

Heretofore, when a group of foundrymen from different plants got together each would have some special facing mixture or ventilating method, or arrangement of nails pushed into the sand with heads on the level with the sand surface or a silica wash, or a new gager or chill that he had developed and of which he was very proud. Each would cite some peculiar intricate casting which had caused the downfall of all those who tackled it, but was apple pie to him with the use of his particular arrangement or method or mixture.

A different condition of affairs is now coming about. A readjustment is now going on in this industry in methods of molding, melting and sand handling. An entire new set of factors are cropping up upon which the manufacture and sales of castings is based

The changes in foundry methods now going on are an enormous factor in the increased production of the improved type of foundry. Close competition is demanding a vastly improved manufacturing method that will produce a higher yield of good castings at a vastly lowered manufacturing cost, with lowered overhead, lowered repair costs, and all of it with a fraction of the labor that has been used heretofore. Profits are so low, in some foundries, that unless radical changes are made they will be forced to discontinue business.

They all admit that something must be done, that profits are getting lower and lower, that there are too many foundries in the business, etc., but none want to admit that there is much wrong with their individual plants. There are some, however, who see the light and are doing considerable house cleaning by scrapping old and obsolete equipment and methods. Largely the latter.

One great necessity is to eliminate the laborious operations by skilled labor in the plants having a machine or two on one hand, and on the other hand the rebuilding and rearrangement of some complicated mechanical installations which are so extensive and top heavy that the cost of repairs have become prohibitive and legitimate expansion hard to bring about. The owners of some of them would be willing to sell the greater portion of them for a fraction of their original cost.

We must reduce all but a very small proportion of the operations to mechanical ones—eliminating the slow, costly manual operations, and standardize all practices so that they are rendered, as much as possible, independent of the judgment and imperical knowledge of the man. They should be simplified and be as sequential as the product will permit.

The losses and wastes in labor and material are enormous. They have become accepted as evils, but unpreventable ones. It is conceded that after careful analysis that the average loss in castings amounts to as much as 10 per cent of the total cost. The losses are the greatest in the jobbing foundries.

The Department of Commerce Report for 1923 showed the value of castings sold to be $515,250,000.00. Now 10% of this amount represents a goodly sum of money, and this loss indicates poor efficiency

*Presented before Cleveland Section, A. I. & S. E. E.
†Consulting Engineer, Cleveland, Ohio.

in the foundry since most of it is preventable. The Blast Furnaces do not scrap 10% of their pig iron; Steel Plants do not throw away 10% of their plates, rails and structural shapes; Automobile Plants do not reject 10% of their cars. It is the apathy of the owners; also lack of competent study and absence of co-operation by the operating men who are responsible for this serious situation.

Economy must be our watchword. Everything must be done at lower cost. We must look to what becomes of the dimes where formerly we looked to the dollars only.

Economy. We see it everywhere. In the reorganizations, the rebuilding and developments in industry; the lowering of manufacturing costs; lowering of overhead and upkeep costs particularly, but—economy must be brought about. It is the paramount factor. The mere fact that we have reduced former hand operations to mechanical ones, thereby increasing production per man, is not sufficient. They must be further developed so that the processes are in the most advanced stage possible.

The foundry has been running in circles and getting nowhere. There has been an absence of policy or program. We cannot go on in this way, and continue in profitable service. We must get out more product per man without unduly loading him, and without causing any additional fatigue. We must speed up the output by eliminating as many movements, operations, practices (especiallys practice) handlings, and variables that cannot be controlled, and above all, little discretionary processes on the part of the molder. We must eliminate the human factor in production wherever possible.

The reduction of the entire process of making castings to a predetermined and knowing condition is now becoming imperative. We must become more skilled in the manufacture of castings. We must have more control over the various operations that go to make the various parts of a complete mold ready to be poured and those that go to make up an accepted casting after it has been poured.

We must do things along prescribed lines all of which have been carefully decided upon before hand, including the maintenance of the plant. The equipment must be inspected and overhauled at stated intervals so as to intercept troubles at their source. Most breakdowns and burnouts are direct evidence of ignorance, neglect, or mismanagement and are preventable, but the foreman and the workers will not favor this while it can be prevented, especially since it is not the whole hearted desire of the management out in the plant that it be done.

This is what we need. Reduce the operations to predetermined and pre-investigated conditions outside of the local and individually delivered opinion of the manager or foreman or superintendent and which he has based upon his 10 or 16 or 25 years' experience.

We must make castings which, when completed, will be to dimensions and free from distortion. The trade is demanding lighter castings every day. The designers of castings have been responsible for an enormous loss in unnecessary weight of a good deal of the castings manufactured and which should be eliminated. All this means electric melting, electric annealing and heat treating, and what is equally important, positive and continued uniformity in sand conditioning with the definite assurance that the process can be repeated tomorrow and the day after without any of the hundred or so variables, now existent, being injected into it.

Now, we might sum up and say the economical operation of a foundry depends upon the: first, reduction of the various parts of the process to a predetermined mechanical process; second, the simplification of the mechanical train of apparatus to the fewest number of pieces or units that will move the product, and these to be electrically operated; third, that these be standardized in as many parts as possible; be of sufficiently heavy construction so that no possible movement of the product or accessories can disable it; that the equipment be ample in capacity and heavy enough that it can be handled without abuse; fourth, that foresight be incorporated in their designs; that more study be given in eliminating sources of trouble, that is, that repairs be prevented rather than performed; fifth, that all hand operations in making a mold be eliminated except those of placing the cores and closing the mold.

All laborious operations and actions upon the part of the workman will be eliminated. The scarcity of labor, alone, aside from the humanitarian side of the situation, demands this. If all the industries of the country were to operate at 100% of capacity, there would be a shortage of labor today.

We must build the machine and arrange the equipment of the plant so as to eliminate the necessity of even common labor. Of what need have we for common labor anyway except for straightening and cleaning up around the plant.

The day of the common laborer has passed; the day of the tradesman, such as the machinist, the molder, etc., is passing, and in his place we have the machine operator whatever the machine might be, or a single operation specialist. We will always have a certain number of super skilled men who will produce tools, dies, jigs that the machine hand will use, and the finisher or core placer who will place the cores, close the parts of the molds made by the machine hand, slick it up and, get it ready to be poured.

Sand Control

Of all the sources of trouble causing the rejection of the castings, sand and melted metals are the two most serious. Of these two prime causes, less is known by the industry in general about sand and its contributory causes than about metals. It has only been within the last year or so that any serious consideration has been given to the proper daily examination of sand, and its effect upon rejections, or that adequate sand control has received anything near like the attention that it deserves.

We now have melted metal and sand from which a casting is produced. Each of the two, in its relation to casting production, is reduced to a scientific status. Chemical and physical analysis of metal is now an established science, and we can say with precision just what a metal is; what its physical properties are; we can also tell what has caused failure; where the process of its manufacture has fallen down, and where the responsibility for the failure should be placed.

During the past two years or so, the same has been developed for sand. The process now of conditioning, handling and ramming sand has been re-

duced to a standard basis. We can, by chemical analysis and physical tests, determine the condition of the sand at all times, together with its effect upon the casting, good or bad, and as in the case of the metal, we can determine definitely the causes of trouble, where the process fell down, and upon whom the responsibility for the failure should be placed. No longer will those responsible be able to blame the cause of rejection on the binder used in the core sand, or that too much ajax and not enough flour was used in the facing, or that the molasses was left out, or that the mold was not properly "nailed." The cause of the trouble will now be chased down to one or more of a very limited number of causes and the chasing will be done by the laboratory.

Every effort now is being made to reduce the examination of sand both old and new, to a few standard and stable factors, to a few uniform tests which will arbitrarily decide in just what condition the samples under test are at the time.

This has not yet been entirely worked out to the satisfaction of all. Considerable controversy yet exists, but a great amount of good work has been done and sand control is with us. This is our greatest necessity today, stabilizing the sand all the way from the new sand pile to the conditioned sand in place in the mold.

It has now been proven in more than one plant that sand is responsible in some form or other for at least 80% of casting rejections.

At present the testing of sand is in a somewhat jumbled condition, due largely to the contempt of certain individuals for the comprehensive set of tests as adopted by the Foundrymen's Association and considered by the trade as standard. The value of those tests lie in their adoption by all so that all tests are referred to a common standard. Unless they are relative they are useless.

Now if some or all of these tests are slow, or cumbersome, or top heavy, or inaccurate, and are not characteristic of the actual conditions, they should at once be revised so that they are acceptable to all, and those that might tend to promote skepticism should be instantly abandoned. The dye absortion tests would probably come under the latter head. It is not used at all in certain sand testing Laboratories which are otherwise complete, including the Smith Vibratory Bottle Test.

There is too much controversy at this time as to methods of making tests, and not enough sinking of personal opinion for the common good that should exist in an industry of this magnitude.

It is possible that the individuals desire to attract public attention to themselves, rather than to perform a disinterested service to the industry when describing their particular short cut method, together with their special apparatus which they use in place of the American Foundrymen's Association standard method and apparatus. Now, since we all admit the necessity for a set of standards, why not live up to those decided upon or immediately revise them. All special test methods incorporate more or less imperical information for their successful use. If we are to resort to special methods where the absence of personal knowledge of small details might inject an error, why not utilize Eugene Smith's vibratory bottle test which is the most complete single test that exists today and which is considered to be the Daddy of Sand Control.

The Smith Bottle test without doubt can convey more information to its originator than it would to the average man making tests in the foundry. A controversy exists as to what is considered as bond in the vibrated sample. Without doubt, the originator of the method could interpret visually what constituted bond and what constituted pan material by reason of the thousands of tests he has made, but could we all do that? It is the elimination of as much special knowledge and information required by the operator that is one of the most important factors in sand testing.

These controversies lead to nothing. We have a problem before us that must be solved, the solution is the paramount issue, not the controversy involving the claims and counterclaims of individuals. I agree, however, with the originator of the vibrating test when he stated in "The Foundry" "——— firmly believes that the time is not far distant when the man in the foundry will solve his own sand question, and its relation to his losses by some simple, practical method, and the enormous waste each day caused by the improper use of sand or use of improper sand will cease."

Am of the opinion that this simple test will be forthcoming, but that it will be an evolution of the standard Sand Tests of the A. F. A. which will in all probability be revised in the near future.

The great necessity for sand control in the foundry is becoming more apparent every day, but by lack of interest on the part of those most interested it has not had the attention it deserves. There is an unwillingness on the part of certain active managements to admit that their sand situation is what a comprehensive study of their sand methods would show it to be. They do not want to admit that they have known so little about the sand and its effect upon their losses, and from experience I do not hesitate to say that obstruction to, and derision of its adoption in certain plants where it should be used, will be practiced.

However, the factors that governed business two years ago differ entirely from those that exist today. The trade is now more discriminating. It knows better what it wants and has had ample time and opportunity to analyze what the effect of its purchases will have upon its production and costs. Therefore, it will have what it wants and the foundry that furnishes the quality and quantity desired at the lowest price will get the business. The profit that will result from this business will be the difference in the manufacturing cost and what the purchaser will pay, not what the foundry wishes it to pay. The price the purchaser will pay will be fixed by that which the most economical of foundries will charge. Therefore, if a lot of the foundries expect to continue in business, sand control of some magnitude will be instituted and the foundrymen will admit this. Therefore, sand control is with us.

Continuous Foundries and Sand Systems

Now up until a few years ago, the bulk of automotive castings were made on the outside, but recently some very important foundries have been built within the Motor Car Plants, and if the foundry industry intends to hold the remainder of the business it must revamp and rearrange its foundries, and

above all, it must simplify and electrify them to the last degree. It simply must make the casting cheaper than the customer can do it himself, that's all.

This foundry situation is going to work itself out economically. No other factors are going to have much influence over it. It is purely a question of production costs. The foundries that now hold the business must lay the castings down at the receiving department of the motor car plant, for instance, cheaper than it can build a foundry and do it themselves. On the other hand, the motor car plant that owns its foundry or controls one, must lay the castings down at its receiving department cheaper than a modern simplified foundry on the outside can do it or close down their own casting departments.

To go into details as to theory and calculations is out of the question here. Our field, at this time, is to try and point out some of the faults, frailties and fallacies of the foundry in general, excluding perhaps the majority of the plants built within the last two or possibly three years.

For this reason we are dealing with the basic ideas and fundamentals which underly the founding of iron and steel, and to put the existing interpretations of them on a comparative basis wherever possible, together with the possibilities in savings that could be brought about by simplification, etc.

It is the intention to show continuous sand handling and molding systems in steel and iron foundries to some small degree. It is this continuous action in the foundry, together with the application of electric heat in melting and annealing furnaces, in drying and core baking ovens that will be the most important improvement in casting production. Continuous systems can be adopted to both small and large foundries where molding on a production basis can be adopted. There will, however, always be foundries where this type of apparatus cannot be applied. The apparatus is sequential in its operations and is the essence of simplification.

The continuous operation is the logical one in any industry where it can be developed. It is in use in the Steel Plants, in Motor Car assembling, in Heat Treating—in fact, in any number of manufacturing practices.

I recall an experience of twenty years ago in Cleveland that will be typical of the situation that exists in the foundry as compared with modern manufacturing methods. A machine shop of considerable size secured contracts to build seven hundred (700) automobile engines. Part for the old "Wayne" and the balance for the old "Northern" car. In the assembling room about 50 assemblers worked at benches, each man having a vise on the bench and a small frame on two horses on the floor rigged up for assembling an engine. Each man took the parts of an engine and assembled it complete, he scraped in the bearings, he fitted the pistons, he put in all bolts, he assembled the complete engine while on that frame. If he was careful in all details, a corresponding degree of efficiency and operation of the engine resulted. If he was careless or crude in his methods, the opposite was the result, but in none of them could a uniform condition be brought about in any two engines.

This method was diametrically opposite to that which exists today. In the method described, one man performed every operation in the assembling of one engine Today one man performs one operation in the assembling of every engine. The relative effects in the two methods are obvious. Now, the average foundry today is only just as efficient, only just as far advanced in production methods as that machine shop was twenty years ago as compared to the modern methods of producing the same work today.

The apparatus shown here is merly intended to give the trend of development, and to be somewhat typical of the situation. It was the most available for the purpose, but it is not to be considered as the sole solution of the problem.

Heretofore, the accepted practice in the best foundries, except in one or two cases, was to make the molds, then set them out on the floor in rows or groups until time for pouring when all or a portion of them were poured. The molds, all or a portion of them, were then shaken out, the sand and flasks were returned to the molders for use, the floor cleaned up wholly, or partially, and the process repeated. The operation was intermittent, and in all cases floor space was a limiting factor in production.

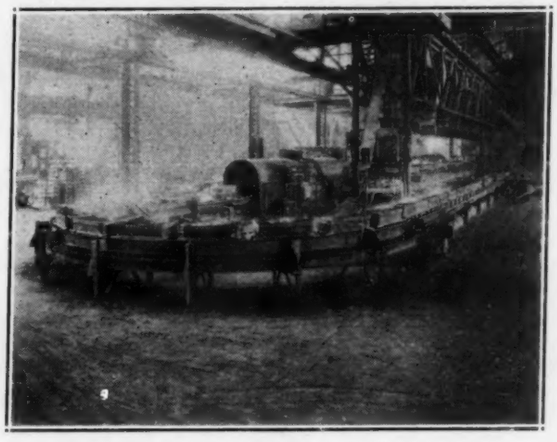

FIG. 1.

Some of these foundries were well handled, and the molds, sand and flasks arranged and laid out in an orderly manner, while others—by far the greater majority—were nightmares in their appearance, their utility and their arrangements.

We have now in existence the continuous foundry in both Iron and Steel, where the molds are made, the metal poured into them, the sand shaken out and conditioned, and returned to the molder for use again. All of this without setting a mold on a floor. Everything being done on conveyors—the action being rotational. The flasks and sand actually being used once an hour in one case in mind.

In this type of foundry, vastly increased production can be secured with only a fraction of the floor space and the labor that was required in the best of the conventional types of foundries. In addition to this, since the molds must move and be handled at a scheduled rate, all operations that enter into the production of a mold and later a casting must proceed at this scheduled rate—thus eliminating any sluggishness in the work by any of the workers. All must perform his part of the work at schedule speed or the movement piles up at that point.

Figure 1 shows a continuous foundry in an automotive plant in Michigan as developed by the C. O. Bartlet and Snow Company of Cleveland. This plant, an iron foundry, is continuous in its operations including sand handling and conditioning.

In its operation, the molding machines are located on the floor directly under the overhead sand bins or hoppers which in turn are located in the steel structure shown in the upper right As the copes and drags are made, they are set on the conveyor, the cores placed and the mold closed. When the gaps

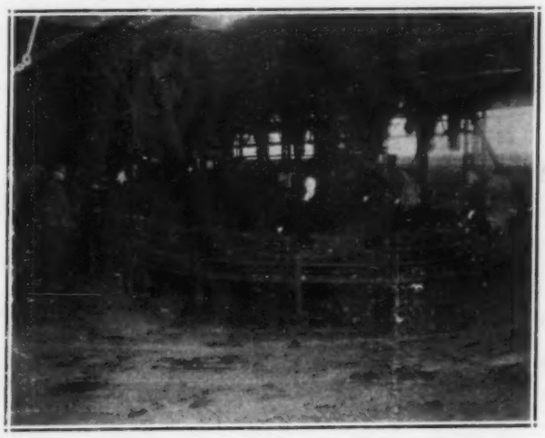

FIG. 2.

are closed up, a train of molds is formed. This train is then pushed along the slide rails of the conveyor, and up to the pouring position where they are then poured from a ladle swung from an overhead monorail. The poured molds go around the turn in the conveyor and are pushed along through the ventilated tunnel where they are cooled to some extent, then on a little farther on to the knock-out from whence the sand goes to the sand conveying system and the flasks back to the molding machines.

In this way, the flasks and sand are used a number of times a day. The entire operation of making the casting is now concentrated—allowing a single observation to cover it all; the system completely eliminates the necessity for a molding floor.

Figure 2 shows a view of the same system with the picture taken at the same end, but from the opposite side. This gives an excellent view of the arrangement under operating conditions. It shows the metal being poured into the molds, and the movement of the molds around the gravity turn in the conveyor then into the cooling tunnel to the shake-out. This view also gives an idea of the possible concentration of operation by the number of sand hoppers shown in the background—each serving a molding machine in addition to those shown in the system in the previous view. Sand can be seen discharging from the gates of two of the hoppers directly back of the ladle man.

Figure 3 shows a continuous foundry for making steel truck wheels, located in Southern Ohio and developed by the Osborne Mfg. Company of Cleveland. It is continuous in its operations both in production of molds and in handling and conditioning of the sand.

In this foundry, the molds are made at a group of molding stations or units. Each unit is made up of two molding machines, one for the cope and one for the drag. The two machines are served with sand from a flask filler, the discharge spout of which can be seen hanging down between the two molding machines and to the left of the men in the picture.

The copes and drags are taken from the machines and placed on a short section of conveyor arranged for the purpose at each molding unit. The cores are placed and the mold slicked up and closed on this piece of conveyor. They are then taken by a transfer car, which is also a section of a roller conveyor and transferred to one of two longitudinal conveyors which are in the neighborhood of one hundred fifty feet long and running with the building. The two being parallel and separated from each other by ten feet or so A section of one of the longitudinal conveyors and a transfer car are to be seen in the lower right. The longitudinal conveyors are arranged so that the transfer car at each molding unit crosses through both, and molds from any of the three units can be shunted to the right or left on either of the conveyors. The molds are poured on the longitudinal conveyors, which thus form a pouring position; steel being available about every forty minutes. Converters and electric furnace furnishing the metal. After the molds are poured, they are run down to the shake-out by a conveyor continuing from one of the longitudinal ones.

After the molds are shaken out, the flasks are returned to the molding units, and the sand goes into the sand handling and conditioning system to the flask fillers at the molding units. All the operations from the molding machines to the shake-out including the pouring is done on the conveyors. The enormous saving of time, labor and floor space over the old method will again be self evident.

A mistaken idea may be formed that the continuous foundry requires the same casting to be run over the system for a given period. This is wrong, the

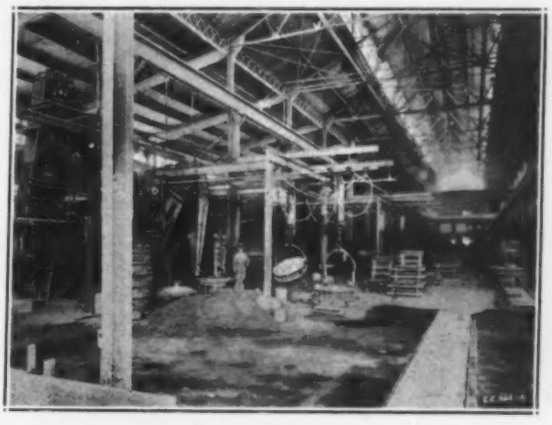

FIG. 3.

only limiting factor in the continuous plants shown here are the size and shape of the flasks. In Figure 1, it is possible to have the pattern for a different casting on each molding machine and so far as the operations in this view are concerned, this might actually be the case. The flasks must fit the conveyor and go around the turn, that's all. Assuming of course, that the same grade of metal is to be poured.

When you limit the floor operations or work to the service of an overhead crane, you then limit the

efficiency of the man and his machines, hence his output to this service. The machine can operate throughout the day only as fast as it is served with flasks and the molds are taken away. In fact, this inherent condition has been one of the limiting features in the production per man or the man hours per ton in a number of the best plants. It has, heretofore, been accepted as such until the readjustment began two or three years ago.

In this foundry, making steel castings in green sand, only one grade of sand is used in the mold—no facing, no backing—just molding sand. All of it has been completely conditioned and is uniform in texture and consistency. Sand control is in use, and the conditioned sand is uniform throughout in permeability, cohesiveness, moisture content, and grain size, etc.

This sand handling and conditioning system is highly simplified and is operated throughout by one man who has control of all the units going to make up the system where formerly twenty-three men were required. A saving of 22 out of 23 men. The screened and separated sand from the shake-out is conveyed by a heavy steel incline distributor driven by a variable speed D. C. motor to a mixing belt. Another incline distributor conveys new sand from a storage bin to the mixing belt from the opposite side. Finely ground fire clay is added to the sand on the mixing belt, and all three ingredients are accordingly fed continuously into the bar type conditioner which is shown in detail in Figure 12.

The three ingredients are delivered to the mixing belt in predetermined exact amounts which are fixed by the speed of the conveyors. Hence, no variable factor enters into this portion of the mixing.

The entire system is made up of about six or seven drives; is highly simplified and is unusually rugged in its construction and parts. The discharge end of the conditioner can be seen at the extreme left edge of the picture. The conditioned sand is lifted by the bucket conveyor and delivered to the flask filler at the first of the molding units, or by a deflecting chute to a conveyor which carries it to the flask filler at the second molding units, or by another deflecting chute to another conveyor which carries it to the flask filler at the last molding unit, or if it is desired, by deflecting chute to a car on the floor.

Only the continuous process will survive. The batch mixing has existed this long only by the backwardness of the industry. The one way continuous operation has proved the best and only possible one in so many and diversified industries and processes, that it has become almost a law.

The continuous milling or mixing of sand for steel foundries is not a new thing. A continuous system has been in use for a long time in one of the large steel foundries in the St. Louis District by one of the Steel Foundry Industry's most able pioneers. This foundry enjoys a most enviable reputation in the manufacture of large cast frames with long thin sections integrally cast, but shaped like a structural fabrication. This system has had a good deal of discussion for and against. It was considered, to some extent, as a hobby, but the wisdom of its adoption is becoming more obvious every day.

In the conditioning of the sand, it is evident that a more stable and uniform state will be produced by conditioning or mulling all the sand that goes into the mold, although both facing and backing sand is used. In no other way can uniform permeability be brought about.

The additional first cost of a comprehensive simplified system is worth the expenditure in the peace of mind and absence of worry of the Executive Management. It should even lengthen his span of years and leave him in a healthier condition in his old age.

Conveyor Systems

There appears to be a tendency to relieve the overhead traveling cranes of some of their operations by the use of single overhead rail type of hoists both power and manually operated in conjunction with roller tables, and the flat types of conveyors.

This is one of the readjustments now going on within the industry. However, the situation has not yet been sufficiently stabilized to prophesy whether electric or air hoists will dominate the field. The electric hoist is without doubt the more applicable. The air hoist may probably be abused to a greater extent and still make a lift, but with the simplification of the gearing and parts that has taken place in the electric hoist and the further improvements the future holds, the electric hoist will survive over the air hoist by reason of the inefficiency, absence of flexibility and upkeep cost of the air hoist.

The use of roller tables is growing more extensive every day and are also beginning to supplant other handling methods. At present, the rollers are all idlers and are operated by hand power and gravity. In some cases, the train of molds or flasks are pushed along by an air pusher or dragged along on rails by a chain conveyor. The future offers a bright field for power driven roller tables as conveyors, similar to the roller tables used in the rolling mills.

We are going to use these tables, in the future, like the tracks of a freight yard, and all arranged for switching from one table to another and to main trunks, etc. Future founding, except in very large castings, will be done on conveyors.

The necessity for bringing the mold to a pouring position instead of bringing the ladle to the individual floor position of each mold is becoming more apparent every day. Its possibilities will be obvious at a glance from the methods shown in these continuous foundries.

I have discussed this arrangement in a number of the large steel casting plants. I have one plant in mind in Ohio where the Manager insisted that it was not possible to bring his mold to a centrally located pouring position or location; while in a plant in Iowa making the same castings for the same trade, they have been doing this very thing for some years—using a type of buggy for the purpose. This arrangement vastly simplifies the situation as the Ladle Crane, while pouring molds on the conventional floor, ties up the entire floor while it is pouring as it is almost invariable No. 1 crane at the end of the runway that acts as the Ladle Crane. I have seen No. 1 crane, while pouring a heat force, Nos. 2, 3, 4 and 5 cranes, operating on the same runway entirely out of commission for periods of from 5 minutes to a half-hour, and this in more than one foundry. This is waste.

In another plant in Pittsburgh, a somewhat similar arrangement is in use—where the foundry is ar-

ranged with short molding bays which branch off the central main bay. The molds are brought from the molding bay as they are made and are laid on a pouring floor in the main bay which also carries the melting furnaces. This constitutes a pouring position where the operation, in no way, affects the production of the molds. The shaking-out and sand removal is all done on this pouring floor and in no way affects the molding bays.

Now, if it has been good policy and has been profitable in Iowa and Pennsylvania, it should be the

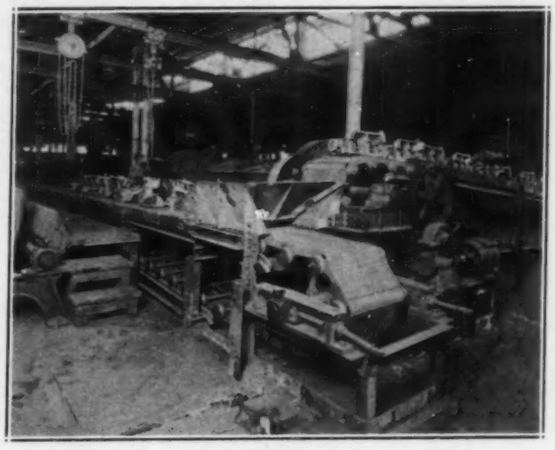

FIG. 4.

same in Ohio since the same castings for the same trade are made in each of the three plants. If it is actually not feasible in the plant in Ohio, and this is not merely an arbitrary statement, then there must be something wrong with their process of making the mold. However, the necessity of reducing manufacturing costs will force an investigation of this important policy in founding—in this as well as other plants.

The adoption of a conveyor arrangement to handle the situation will be the logical conclusion in the majority of cases while they may not actually be in the nature of those shown or discussed here.

Figure 4 shows two flat type conveyors handling rough castings, acting in conjunction and arranged at an angle of 90° to each other. It is built by the C. O. Bartlet and Snow Company of Cleveland and is in operation in an iron foundry devoted to automotive casting; located in Cleveland.

In the operation, the conveyor at the right runs past the knock-out stations where the cores are knocked out of the castings, after which they are placed on the moving conveyor. The castings drop off on to the moving conveyor which runs on down to the left past a row of rattlers; the end of one of the rattlers showing at the extreme left side of this view. The castings are lifted off the conveyor and are placed in the rattlers. After being tumbled a certain length of time, they are finished by grinding and chipping at stations located parallel to the row of rattlers.

I noted the efficiency of the entire cleaning room of which this view forms a part. This conveyor arrangement is one of the best time savers in the industry. The concern where this conveyor is located has developed and patented a core sand knock-out for this type of work that operates very effectively.

This is an exceptional view of the arrangement of conveyors as you will note. It gives a definite idea of the nature of the drive; its type, arrangement, construction and adjustment, together with its application with reference to the equipment it serves.

Here is shown an idea of the trend in casting distribution and handling. Heretofore, this grade of work was done by overhead cranes which handled the castings in boxes or racks. A large part of it is still handled this way, but the future foundry must consider this movement in continuous operation.

Figure 5 shows a continuous sand conditioning system made up of the same units as that used in the handling system shown in Figure No. 3, but arranged in a different manner, and installed in a steel foundry in Eastern Pennsylvania.

In this Plant heavy castings are made; the flask containing sand and casting is placed on the shake-out in the foreground and jolted, the sand passes through the heavy grating and is carried up on the bucket distributor just beyond. It then passes over a screen and separator whence the screened sand drops into a bin for return through the conditioning units to the handling and distributing system while the refuse passes up over the inclined distributor into a car. All the sand in the system is conditioned or mulled by passing through the bar conditioner; it is not just "cut over" or "aerated."

A heavy cast steel bucket distributor driven by a variable speed D.C. Motor takes the old sand from the bin and delivers it at a uniform rate to the mixing belt shown in the middle background, while another bucket conveyor, also driven by a variable speed D. C. Motor, shown at the fore-end of the mixing belt, and just in front of the concrete wall of the sand bin in the background, carries the new sand from this bin and delivers it at a uniform rate

FIG. 5.

also to the mixing belt. A small hopper, not visible in this view, delivers the bond to the mixing belt, whence all the ingredients are poured continuously into the Bar conditioner, in the right fore-ground, and after conditioning, it passes to the sand delivery system at the right but not shown in the view.

The unusual ruggedness of the equipment is shown by the main bucket elevator; each of these buckets is a heavy steel casting. The buckets are connected by a chain made of short heavy forged and heat treated links.

The elevator will negotiate anything that will pass through the shake-out grating without damaging it. A sprue, gate or heavy gagger may engage one of the buckets and a stationary support, but it could not wreck the elevator. The obstructing piece of steel or gagger would be pulled in two, or at the worst the edge of a bucket might bend, but it could not pull it from place.

Have seen a number of bucket elevators in foundries made up of light pressed steel buckets riveted to a rubber belt with ¼" rivet and operating in a

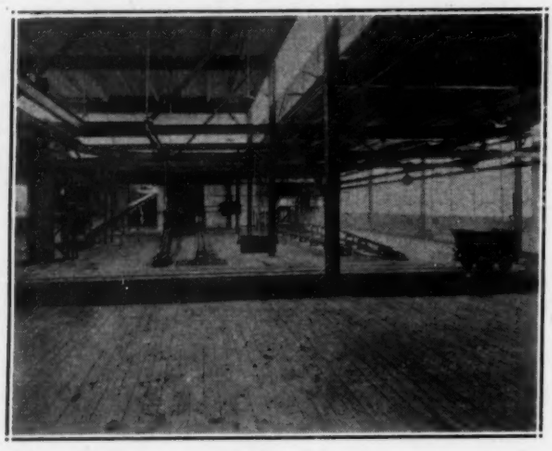

FIG. 6.

sheet steel boot. The pulling off of a bucket in the boot invariably wrecked the elevator by jamming and pulling off other buckets.

In the average system, in present use, the total net delivery of conditioned sand is such that the system must be run for the entire 24 hours in order to deliver sufficient sand for the daylight operations. I have seen it where the entire sand movement over an elaborate sand handling system was first laboriously shoveled and worked through the grating by hand with shovels, and the system could handle the sand only at the rate that the laborers shoveled and scraped it through the grating A slight holdup in this system or any of its parts amounted to almost a criminal offense.

Figure 6 shows the shake-out room in an iron foundry located in Central Ohio. It is part of an installation developed by C. O. Barlet and Snow Company.

In the arrangement shown, the molds are brought in on the gravity conveyors, that is the two low conveyors, to the shake-out gratings shown at the end of the conveyor. After shaking out, the flasks are placed on the power conveyor pushed up over the hump where they are returned to the molding machine.

The sand is carried from the shake-out to the elevator at the left, whence it is screened and separated and discharged on to the inclined belt conveyor and returned to the sand system.

Figure 7 shows a long belt conveyor for delivering backing sand to a group of molding machines located in a foundry in Ohio making railway castings.

The belt is a heavy five ply one, and is more than 900 feet long. Sand is carried approximately 450 feet after which an extension belt takes sand from the end of this main conveyor belt and carries it twenty or thirty feet farther to two molding machines installed later on. This extension can be seen in the center of the opening at the extreme end of the gangway.

At intervals along the conveyor, plows are placed which can be lowered on to the belt thus scooping the sand off into a bin or hopper which is just below the conveyor and just over a molding machine on the floor below. When the hopper is filled, the plow is lifted. The two plows shown down the conveyor a little ways, serve the hoppers over the two molding machines shown in Figure 15. The length of this belt is due to the location of molding machines in the Foundry Bay below.

As stated in the Electrification Paper two years ago, the shake-out of the sand, its reconditioning and complete turnover for use again at the molder's hand is the bugbear of the average foundry.

Usually it is so arranged as to serve molding machines which have been placed without regard to how they are to be served, no consideration being given to its individual effect upon the manufacturing process in general.

In the adoption of a sand system for distribution to all molding machines, the position or location of the molding machine should be governed to some extent by the method of how the sand is to be delivered It is possible to cause a prohibitive complication in the sand handling equipment by their haphazard locations. Machines are added one at

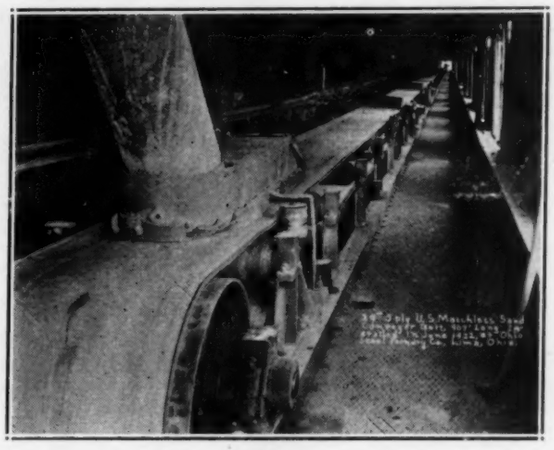

FIG. 7.

a time and located wherever a space appears to permit it. Then, the sand must be brought to the machines. These factors actually govern the nature of the sand handling system, as well as that for the handling of the castings.

With the machines in odd places; not in straight order and scattered around the shop, costly and high priced, special construction and long complicated conveyors and belts are required.

This all tends toward high investment costs, inflexibility and above all it increases the inspection and repair costs. It must be remembered and considered in all developments that every bearing, roller, pulley or gear no matter where it is, must be inspected constantly—thus increasing the repair labor and

cost. In addition to all this, an enormous lot of back tracking is produced in the plant by the lack of foresight in properly locating the molding machines. The time and effort lost through this back tracking in some foundries is appalling. Conditions in the cleaning rooms being even worse.

My experience in some of the larger foundries during the past few years lead me to the certainty that a lot of the so called up-to-date foundries are badly in need of a well built, motor operated and simplified sand handling system of the continuous type.

Molding and Facing Sands

What constitutes good molding sand in any type of foundry, Iron, Steel or Non Ferrous has been a much mooted question—different views being held by different foundrymen in the same line, making castings for the same trade, often from the same patterns.

Take a moderate steel foundry for instance: we now have two radically different methods of making, say a green sand mold, and with three entirely different ways of conditioning, mixing or mulling the sand that would be used, and this up to the filling of the flask with loose sand only. It is not considering the different methods of ramming the sand after it has been placed in the flask.

Heretofore, the established, and what might be termed the irrevocable custom and practice has been to use two grades of sand in the mold; a specially prepared and milled facing sand in a layer next to the pattern, the balance of the space being filled in with "heap" "backing" or "old" sand which had been reconditioned or cut over in some form or other and had moisture added.

The facing sands were invariably special mixes, containing varying ratios of new sand to old sand with liquid binders, with clay and other bonds added; the mass being then milled for a given length of time in either a muller type pan mill or a paddle type mixing mill.

The facing was intended to be refractory to withstand the temperature of the metal: to be uniform permeability and to have sufficient bond strength or cohesiveness to withstand the mechanical strains set up by the metal. But what of the backing sand, what of its permeability, its bond strength, its refracting ability?

We have now arrived at the parting of the ways. We have now injected an entirely different method into the conditioning of sand and the making of a green sand mold for steel castings. In the foundry previously mentioned, one grade of sand only is used, and this is uniformly conditioned throughout the entire mold; all of it passing through one unit in a continuous direction.

Its conditioning has consisted of screening, metal extraction, measured amounts of new sand, old sand, bond and water added and the whole mass then milled, all of this in a continuous process.

This now means that we will have advocated of the two methods, that is the facing, backing sand method, and the one grade sand method. It is not intended here to show that one grade of sand can be used in all steel casting manufacture; that would be asking the impossible; special facing will always be required in certain grades of castings. It has been conceded that an enormous amount of steel castings, now made in baked dry sand molds, could be made in green sand. But the time is with us when all the sand that goes into a mold will be uniformly conditioned.

Now, then, sand is in reality a flexible medium to be worked into the shape of the desired mold by being formed around the pattern of the desired casting. It has no other function. In order that the casting will strictly follow the shape of the mold, the sand must be able to withstand the heat of the metal and be of sufficient uniform porosity to conduct gases and steam away from the metal before they have time to effect the shape or condition of the casting, and be sufficiently strong to withstand the weight and pressure of the metal, without causing distortion.

It requires then only strength porosity and refraction. The simplest method that will bring about these three conditions with dependability is therefore the best.

We may have 25 molds side by side, all made on the same machine by the same man, from the same bin of sand, all poured from the same heat of metal but with varying degrees of density in the sand.

We cannot, therefore, expect to have uniformity in the castings, particularly in their surface appearance, unless the density of the sand is uniform. Uniform density is of the greatest importance. Obviously the gases and steams should escape at the same rate over the entire surface of the casting to prevent entrapping of gases and forming high pressure spots or areas. Aside from the varying degrees of density in the sand, there would appear no other variables. Yet we will get castings in various degrees of quality, from a commercially accepted, perfect casting to a commercially rejected imperfect casting, and all due to non-uniformity in density of the whole mass of sand. Where sand is of the same grade throughout; when properly conditioned, it should automatically have uniform density, thus giving uniform ventilation, uniform strength, and hence producing true surface.

The sand as in position in the mold, heretofore, contained so many variable factors that anything could be blamed upon it without hope of its disapproval. There was the original analysis of the sand; the amount of bond, and extraneous matter it contained in addition to pure silica dioxide, its grain size, its fusing point, sharp or round sand, the nature of the heap or backing sand, its moisture content, its condition of granulation (aeration) and so on. It has been heretofore impossible to change any or all the above variables wholly or in part, not to mention the vast number of different facing mixtures in use each of which is vouched for by some one who should know clearly what he was doing. This is due to the unwillingness on the part of various managements to admit that a state of affairs existed over which they had no control or with which they were not entirely familiar.

The trouble in part has been the inability or unwillingness on part of the foundryman to arrive at some basis of adjustment or method of procedure that could be corelated to a stable standard condition previously agreed upon by all; the unwillingness to accept or adopt the other man's findings, or his ap-

paratus, or his methods, or to admit that others might have better methods of conditioning or better mixes in facings, core sands, etc.

There has heretofore been almost an absence of statistical data and what little was availabble did not carry weight. The foundryman had insufficient confidence in it; he practiced too much evasion and suppression himself to have much faith in the presented facts of others. He defended his own processes too strenuously to admit of or to have confidence in a better one elsewhere. Just as a salesman has confidence in his product and has hunted and studied for talking points and repeated them so often in as convincing a manner as possible, that he gets so he believes them himself. In fact, it is this certainty of opinion in the correctness of his own methods that has been such a drawback to the advancement of stabilizing influences in the art of Founding. There are almost as many processes in making castings as there are foundries.

In what established industry, I might say basic industry, does there exist so many opinions as to how certain operations must or should be performed as in the Foundry?

Let us take the term "Aerated" which is a condition produced in which the sand when it is supposed to be ready for the molder. "Fluffy" they also call it. Just what does aerating the sand consist of? What condition is brought about within the sand itself by mixing it with air. What goes on in the sand during the actual absorption—if any—of the air by the sand? What reaction takes place, and in what way does it improve the sand and why is the air necessary in the sand? It does not break up the lumps; there is no absorption of oxygen by the sand grains—or at least it has not been so determined—so of what use is this air in the sand? After the sand is placed in the mold, the air must all be jolted or squeezed out again, so why put it in in the first place? If there is actually an absorption of oxygen by the sand, in just what form is the oxygen when the mold is completely jolted? If oxygen is actually in the mold by reason of mixing air with the sand, when it was conditioned, what improvement does the presence of this oxygen bring about in the casting? Oxygen is fatal to the metal.

Is it not a fact that the inclusion of air in the sand—aerating it—is but a natural sequence, a secondary condition to another operation, the air in the sand having no beneficial effect; it just happens to be there. Are we not rather granulating the whole mass of sand by breaking up all lumps, large or small, thereby bringing the whole mass to granular condition?

Is it not the granulation of the sand that indicates what is now termed its aeration? It is not considered areated until it is granular (fluffy.) The sand is not granular because of the air that the mass contains, but rather the air in the mass is a sequential condition—an entrapping of air in the sand—during the process of granulating. It just happens. "Aerating" like "revivifying" or "rejuvenating" is simply a figure of speech. It means nothing and cannot be referred to a standard condition by tests.—Hokus Pokus.

Now the most desirable condition that we could produce in the sand would be its most simplified and purest form; and as free from vegetable matter as possible; silica dioxide plus just sufficient fire clay bond to thoroughly coat all the sand grains.

Any extraneous matter in the new sand, any excess bond only acts as a contamination or an adulteration and takes up the space that should be occupied by the sand. This extraneous matter, largely clay, in concentrated form, is a most serious cause of trouble and is responsible for a portion of the rejections; which are due to the difference in density between the localized clay and the sand.

Now, if we could mix silica dioxide and powdered fire clay in proportions that had been predetermined by test and inspection, the fusing point of each being higher than the temperature of the metal, we would have an ideal molding sand, and one that filled all the requirements, assuming of course, that the resultant sand was thoroughly milled and with just the right proportion of moisture added.

We would thus eliminate the holes, pockets, and pipes resulting from entrapped gases and steam, and we would also prevent the formation of cinder resulting from the combustion of vegetable elements contained in the different compounds which go to make up facings, such as flower, molasses, oil, etc., in addition to the various elements in the clays which have fusing points below that of the molten metal within the mold.

This burning away of low temperature elements has also a tendency to weaken the surface strength of the sand, which alters the surface, the shape and the appearance of the casting. It also permits permeation of the sand by the metal and causes the casting to scab. Upon investigation in a Steel Foundry in Cleveland, as much as 40% iron was found in the sand, a quarter of an inch from the surface of the casting, resulting from permeation.

Facing is supposed to withstand the temperature of the metal to prevent burning on of sand to the casting, to carry away the gases, to withstand hydrostatic pressure and the erosion of the metal and so on. The various ingredients that enter into the make up of the multitude of facings are each supposed to have virtues that would bring about these beneficial effects according to the instigator of each different kind of facing mix. We now put all kinds of extra matter in the facing sand to produce some condition or other in it. This matter, as just mentioned, is in both vegetable and mineral forms such as clays, molasses, flour, fuel oil, and so on, and all of it added without knowledge of the secondary effects produced. It is like the man who said his whole life had been filled with troubles, the majority of which never happened.

Many castings that are spongy, porous, with holes and defects at edges and corners are the direct result of effects produced by these added elements. The metal invariably is blamed for the trouble—too lively a metal, oxygen, occluded gases, etc., etc., etc. —and because it is hard to disprove these statements, the metal is obliged to take the blame for an enormous lot of these troubles, but the time is now with us when the sand must take its just share of the blame and it is a very large share I assure you.

In a ladle or furnace that must withstand the temperature of molten metal, the lining is made up of a good grade of fire brick laid up in a thin fire clay wash with the bricks just dipped in the wash and then jammed so close together as they can be

placed, in order to offer a solid surface of fire brick to the action of the metal. Now do we not have just this condition in a mold? Sand grains should be considered as silica dioxide bricks separated by the bond. It is self evident that the bond should be a high temperature resistant and its coating on each grain be as thin as possible; that any vegetable matter in the bond that will burn out, any excess of bond, no matter of what it consists are only detriments to the mold, by taking up space that should be occupied by sand grains. It would be poor practice to leave out bricks here and there in a ladle lining filling the gaps with mortar or to lay up the brick with spaces of varying widths filled with mortar. Therefore the best molding sand should be silica dioxide, each grain coated with a thin layer of fire clay, the two ingredients to be of the highest fusing point obtainable.

Bond in the sand has one function and only one, that is to coat the sand so that one grain will adhere to the other. Free bond in the sand is a contamination, its detrimental effects increase with the vegetable additions, and the lowering of the fusing point of clay.

The moisture content has a decided influence upon the ramming quality of the sand hence upon the permeability of the entire mold. In the operation of a Sand Slinger in a large Foundry during a load test made with a graphic instrument, I have observed the power input to the motor vary from 12 H.P. to 41 H.P. entirely from the variation of the moisture in the sand. The pug mill was not working satisfactorily at the time so that very moist and nearly dry sand was feeding alternately to the slinger. After the moisture content became more uniform the load steadied to approximately 28 H.P. The friction load of the slinger with no sand flowing was slightly under 3 H.P. A 20 H.P. motor at 1800 R.P.M. was used, carrying 33% overload.

If a variation in moisture content can cause such a wide difference in the power required to throw it, the density or permeability of the rammed sand would be correspondingly affected, hence another necessity for uniform moisture content in the conditioned sand.

Now all we require in the sand as conditioned for use is that the raw sand, which originally may have incorporated lumps and pieces of metal, be cleaned and reduced to its constituent grains and then each of the grains to be coated with a bond, leaving the least amount of free or excess bond in the sand, nothing more. Simple this.

But, all sand so conditioned must be uniform throughout in its conditioned shape; the work by the conditioning unit should be done automatically for as long as determined upon, then if the consistency of the sand is to be changed for any reason by changing the proportions of any ingredient the unit should condition the sand so changed, uniformly as long as determined. The human factor should not be allowed to enter the process.

Any change in conditioning should be determined by tests and analysis, all of which are standard in their nature and are comparative, so that the causes of failure in the casting can be chased down to its source and proved, just like the physical and chemical analysis of steel.

We cannot find out anything about the physical properties of sand, new, old or conditioned, by simply taking a handful and balling it up and then breaking the ball to note how it hung together. This gives only a rough approximation of its cohesiveness. We must make physical tests that are comparative and which do not differ one from another by an iota.

Only in this way, can we determine the principal factors in the conditioning. In the conditioning of sand, we are interested most in producing uniform permeability (factor of ventilation) uniform maximum cohesiveness (factor of bond strength) and uniform moisture content.

Sand Conditioning Machines

Since molding sand, particularly in steel foundries, was made up of two grades: facing and backing. The new sand, that went into the heaps, was practically all added by way of facing sand. This facing sand being conditioned in some type of mixer or mill. The facing mixtures were, as previously mentioned, made up of part old sand, and part new sand; bonding material in the form of clay, flour, molasses, water, oil, etc. The milling of these facings torms an important link in the conditioning of the sand, and in all cases observed it has been a costly one, not only in the direct cost of milling, but the loss in time and production by the molders when a breakdown occurred to the mill; or where the mill must be shut down when the cranes are tied up, thus preventing the delivery of the sand buckets, and so on.

There are a number of types of machines for milling, or conditioning of sands and which have been used principally for conditioning facing sands and core sands. We are showing here five separate types of conditioners all of which have their particular virtues in the preparation of sand according to the manufacturers or advocates of each.

There are the pan or muller type mill; the paddle mixer; the sand throwing aerator; the rotating squirrel cage sand conditioner; and the rotating bar mill or conditioner. Other types of conditioning units are in use, but the five shown here will serve to illustrate the diversity of methods.

The Pan or Muller type mill is an adaptation of the old fire clay grinding and tempering mill formerly used in Brick Yards. As used in the foundry industry, the pan mill is not intended for grinding but rather for use as a mixer. It is intermittent in its action being entirely a batch mixer. It is the most popular of the sand mills, and is the one in most general use.

The mill is made up of a circular flat bottomed pan with vertical sides, and with two rolls or mullers mounted 180° apart and which rotate around and around the pan while resting on the bottom. The mullers are mounted on the ends of a spider which is driven through a central vertical shaft and are free to turn on the ends of the spider. The spider is free to move up and down on the central shaft so that the mullers ride on the sand, thus mulling and squeezing forward and sidewise—mostly the latter—the ridge of sand which has been thrown up in front of each muller by a plow arranged for this purpose.

There are two types of the Pan Mill, each being diametrically opposite to the other in its action, but producing an identical action upon the sand. Each of the two types has its advocates and supporters.

One type is arranged with a stationary pan and with the mullers rotating around the pan while re-

volving on the bottom; this is known as a standard mill. The other type is arranged with a rotating pan with the muller in a fixed position with relation to the earth, but each muller revolving on the ends of the spider. This is known as a "Frost" Mill. The relative merits of one type over the other has never been decided.

Figure 8 shows a 10-foot standard Muller or Pan Type Mill, in a Steel Foundry in Ohio used for preparing facing sands. It is arranged with an air operated loading skip and charging chute; a motor

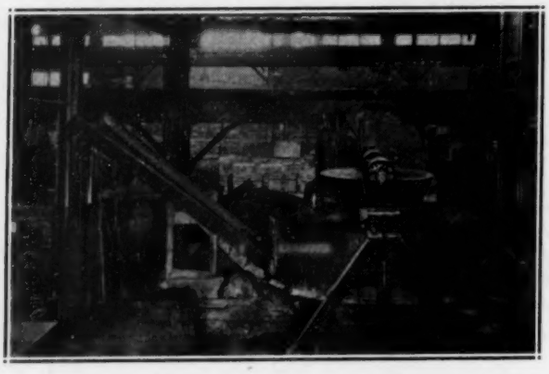

FIG. 8.

operated boot elevator and discharge chute with dump bucket on a small car. The mill is motor driven through a flexible coupling and gearing. The top of the skip bail can be seen at the lower left hand side, while the boot or bucket elevator can be seen at the extreme right side, with the discharge chute, and a full dump bucket just beyond. The buckets of sand are carried by overhead cranes to the molders on the floor.

In the operation the various dry ingredients: the green sand, the dry sand, the old sand, clay, flower, etc., are dumped by wheel-barrows into the skip. The skip is then lifted by the air cylinder and dumped into the discharge chute, whence it gravitates into the mill, with some assistance from the mill operator, due to the angle of the chute. The liquids are in the shape of: molasses, water, silica water, oil, and plain water, and these are added by the mill operator. The mass is milled four to ten minutes after which it is discharged from a gate in the bottom of the mill into a chute, thence to the boot elevator and to the discharge chute and into the dump bucket.

In this view of the mill, one muller has stopped directly opposite the center of the A frame and directly under the cross rail; the upper side is visible above the edge of the pan. The mullers are arranged with tires having about 12" face; they are held on to the muller centers by wedge or key bolts which permits of the tire's removal, after a certain amount of wear has taken place. The vertical sides of the pan are of reinforced plates, and arranged in quarters to allow of quick removal of the muller. This being a late innovation, the bottom is made in sectors to permit of quick removal for wear.

I would like to call attention to the screening of the skip pit, the gear guards on the mill drive, and the safety ladder on the elevator, all of which are highly commendable.

Basically, have never been able to fix the advantage of one type of pan mill over the other. The general dimensions are about the same in each. The pan is usually 10 feet in diameter, while the mullers are around 3 feet in diameter and with 11 to 12-inch width of face. The action of the two types of mills upon the sand are relative; the mullers in each type are caused to rotate by the reaction between the pan and the muller face. It makes no difference whether the muller is pushed along over the bottom of the pan causing it to rotate or the pan bottom is pulled along under the muller causing it to rotate—the effect produced is the same. There is no difference in the mulling action on the sand, it is caused in each case by action of the muller flattening out a ridge of sand by pressure at the line of contact between the muller face width and the bottom of the pan.

The unloading of the mill in the stationary pan is accomplished by opening a slide gate in the bottom of the pan, the sand being pushed out by the action of the rotating mullers. In the rotating pan, it is accomplished usually by an unloading plow which is lowered into the moving sand which is then deflected in a stream into a box on the ground or by a shovel with one corner dipped into the revolving mass of sand deflecting the stream thus thrown up into a box in the same way. Another way is to have a sheet steel box about 12" square hinged above the side of the pan and with one side of the box open in the direction of the approaching sand; as the box is lowered into the rotating mass sand is forced into the box by a scooping action. The box is then raised or turned over, the side of the mill at the hinged edge and dumped into a box or hopper on the ground. The operation is then repeated. This latter method is slow in its action. Have watched a mill being unloaded in this manner where as much time was used in unloading the mill as was used in milling the sand.

The Paddle Mill, shown in Figure 9, is a batch mixer built by the Standard Sand Machinery Com-

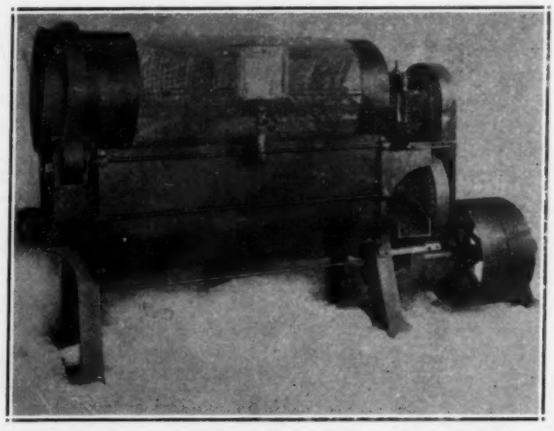

FIG. 9

pany of Cleveland, and is intended for use in mixing facings and core sands. The material first passes over a rotating screen, the refuse falling out of the end of the screen into a chute from whence it is discharged into a box or bucket, the screened material falling into the mixer where the liquid contents are added and the batch then mixed. In this type of mixer, the paddle shaft is equipped with a number

of rows of arms upon which are fixed paddles with their faces arranged at various angles. The paddle arms are of different lengths also, and the paddles have different surface area. The sand in the mixer is moved in different directions simultaneously. One set of paddles tend to move the sand in one direction, while another set of paddles tend to move it in another direction. Other paddles then break up the whole mass and move portions of the sands in still another direction. The idea being to make a homogeneous mass of the mixture.

To illustrate, the arms in one row will have a long end on one side of the shaft, and a short end on the other side. The paddles on the long end will be right handed, while those on the short end will be left handed. The paddle on the long end will have an area perhaps twice that of the one on the short end or vice versa. With the different rows of paddle arms, it is intended to produce an action similar to that of a number of shovels being used to turn over and mix a batch of sand on the floor, only to do it more positively, more effectively and more quickly.

The mixer is equipped with a water tank and a spray pipe for wetting the mixture while it is in the mixer, which is a very desirable feature as the sand should be wet in the mixer proper. The tank permits of a measured amount of liquid for each batch. The mixed sand is discharged from a gate underneath into a box or the hopper of a conveyor.

The manufacturer claims for the machine that by the paddle arrangement, the batch can be thoroughly mixed in from four to five minutes, that by the complete mixing of the mass, the minimum amount of bond material may be used in the mixture since excess bond is not required when the mixing is thorough. Upon the direct question asked, the manufacturer replied that this was not a general statement upon guess work, but that he had proved the fact by tests for permeability and cohesiveness. He also claimed for the machine that there is an absence of clots of sand in the finished batch such as are formed at times in sand from the pan type mill, which comes from great pressure, resulting in packed sand.

This type of machine is made in various sizes with capacity ranging from 4 cubic feet per batch to 27 cubic feet per batch with and without feeder mechanism.

The unit shown in Figure 9 is arranged without loading skip which permits the purchaser to adapt his own device, or a loader can be furnished. In this view, the rotating screen is shown in an inclined position, the tailings falling out of the end into the discharge chute at the right hand end. The measuring tank for adding the liquid content is shown at the front. This particular unit is shown arranged for pulley drive, but can be arranged for motor and gearing as well. The discharge gate is shown on the under side in the center.

The manufacturer states that it can be used for continuous operation, but this does not appear to be possible from its action, as the batch must be worked and shifted back and forth to produce an intimate mixture, then discharged from gate in the center.

The machine shown in Figure 10 is a Royer Sand Separator and Blender, built by the Royer Foundry & Machine Company, of Wilkes-Barre, Pa. It is sometimes referred to as the "Sand Hog."

The manufacturer states that the object sought in treating the sand was to separate each grain of sand and clay from the other and blend the entire mass treated, liberating the gas in the burnt sand and introducing the maximum amount of oxygen into same.

In the operation of the unit, the sand is shoveled or fed by conveyor into a hopper under which operates an endless belt studded with heat treated

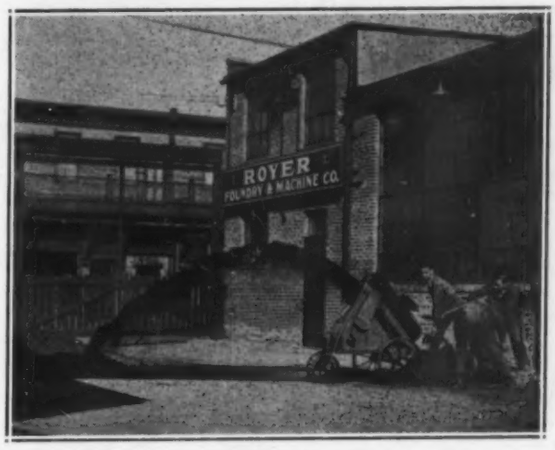

FIG. 10.

springs, and so set as to form pockets equal to a one-eighth-inch screen; the belt operates at approximately 950 feet per minute.

The springs rake or comb the bottom surface of sand, the fine grains lodging in between the springs which carry them past a sweep used to retain the surplus sand and scrap into the hopper. When the belt carries the fine sand beyond the sweep in its passage around the upper pulley the sand lodged between the springs is discharged by centrifugal force and is thrown through the air in a fluffy condition for a distance of 14 feet.

It is stated that the stream of sand leaving the machine which is 16" wide and 14 feet long only equals in bulk the shovelful that is entering the machine shown in the photograph. The machine has a capacity of 1,000 pounds per minute when fed by a conveyor of this capacity. The Machine is driven by a three-horse power motor which is located inside the machine in a dust tight compartment and is arranged to take any standard make of motor to suit the local foundries' power conditions.

The machine shown in Figure 11 is a Bartlett and Snow rotating sand conditioner built by the C. O. Bartlett and Snow Company of Cleveland.

Briefly the machine consists of a short cylindrical cage made up of two outside rings between which the spokes are fastened. The sand which usually passes over a tempering belt where it is moistened—passes into the conditioner in the center of the revolving cage.

The cage is mounted inside a rectangular steel plate housing open at the front to permit flow of sand to the inside of the cage, and open at the bottom to permit the outflow of conditioned sand. The cage rotates inside the housing at a moderate speed.

As the previously screened and moistened sand is fed into the cage, it passes between the spokes when all the lumps are broken up, and the machine cuts, aerates, blends, tempers and fluffs the sand in proper condition for molding. It is also claimed that the grains remain intact. The conditioner is sometimes arranged with a pug mill just ahead for special conditioning purposes.

The conditioner is motor driven through a belt or chain; a flywheel is mounted on one of the drive shafts, to stabilize the speed and variable loading

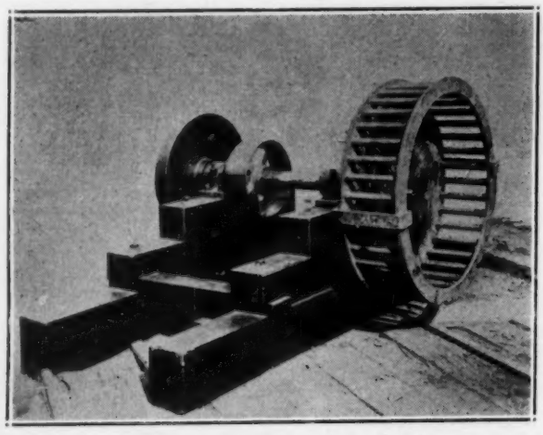

FIG. 11.

conditions. I am informed that the machine is also arranged with an outer stationary cage in close proximity to the revolving cage, and is then known as a Disintegrator.

Figure 12 shows a continuous rotating bar type sand conditioner, which is in use in Steel Foundries in Ohio and Pennsylvania. It is used for conditioning all the sand used in those plants. It has been developed by the Osborne Mfg. Company of Cleveland.

The bar type conditioner, like the Pan Mill, is also an adaptation of a grinding mill used in the brick and cement industries. Like the pan mill, it is also intended as a mixer and not a grinder, as applied in the Steel Foundry. This is the first adaptation of this type of conditioner in the foundry industry.

Its adaption is an innovation in sand conditioning and I might say that if it should continue to produce results as successful as those already met with that the machine will constitute an epochal feature in the conditioning of sand. As such it will exert a large influence on future conditioning methods, also upon the actual constituency of molding sand, particularly in the Steel Foundry. It may revolutionize the entire method of conditioning sand in the Steel Foundry.

Basically, the conditioner consists of a circular steel plate shell of a length probably twice its diameter. A casting is fitted to each end, one at the receiving end with openings to receive the incoming sand mixture and one at the opposite end with openings for discharging the conditioned mixture. This conditioning or milling action is continuous, the mixture passing through in a continuous stream.

The conditioner is rotary in its action, ring castings are mounted on the outside of the shell and rest on rollers. The mill is rotated on these rollers continuously and is driven by a motor connected to a gear mounted on the outside of the shell. The machine is equipped with an inner shell which can be replaced for wear.

The mixing or mulling is produced by the action of a number of round bars one upon the other and lying loose inside the shell. When the mill is empty of sand and stationary, the bars just lie in a bunch in the lower part of the shell, or similar to taking a short horizontal tubular boiler, cutting the tubes off at each end just inside the tube sheet and letting the tubes fall to the bottom of the boiler in a bunch. The sands and bonding material, in measured amounts, are fed into the receiving end, while the conditioned mixture discharges at a certain rate from the other end, leaving a uniform amount or volume of sand in the mill in process of mixing.

This mass of mixture in the mill is distributed uniformly along its length and together with the bunch of bars, all rotate with the mill which is elevated some at the receiving end. This constitutes a mass made up of a group of round bars between each of which is a cushion of sand. The mixing action is the pressure of a bar upon the sand between itself and adjacent bars, and between bars and the inside of the shell as they roll over each other; it is not unlike the action of the muller upon the sand in a Pan Mill except that the line of contact in the bar mill is perhaps 60 or 70 times that of the muller in a pan mill at any given instant, as set forth by the manufacturer.

All liquid additions are made in the conditioner itself, added to the incoming constituents on the delivery belt, and the discharged mixture has been uniformly milled in a continuous process as it passes through the machine. The manufacturer states that sand for use in making green sand steel castings without any facing has been thoroughly mixed, old sand, new sand, bonding material and water—in a period of 1½ to 2 minutes, and that everything entering into the mixture is in continuously measured quantities and proportions and without change in speeds of apparatus. Therefore, there were no variables entering into the sand as delivered to the mold. It was uniform in consistency as determined by tests for permeability, cohesiveness and moisture, and since only one grade of sand was used in the flask the ventilation of the mold was uniform throughout.

It is noted from Figure 12 that the unmulled ingredients enter the conditioner through the chute at the right hand end and leave it through the openings in the end casting at the left hand end: whence it is delivered by a chute to a bucket elevator for distribution.

It has been shown in late sand tests, that the cohesiveness of the sand is the result of coating the sand grains with the bond; that in addition to mixing and blending of the ingredients, it is necessary to coat each grain of sand with the bond and anything in excess of this is simply free bond in the sand which becomes a detriment.

Heretofore in milling sands, the grains did not receive a sufficient amount of rubbing under pressure, and in place of using all bond material to advantage, only a portion of the amount added in the mixture was effective; for this reason it has been

the practice to use excess bond without knowing why.

In the plant in Ohio just mentioned making green sand steel castings, the castings were of thin section, and with surfaces which were to be painted; it was the old practice to use two grades of facing sand and the balance of the space in the flask filled with heap or backing sand. In the operation 50% of new sand entered the foundry daily. A superfine facing next to the pattern was used first, then an ordinary facing next, then the backing sand. This arrangement had been developed as necessary to produce a surface on the casting that would be satisfactory.

After the new continuous system was installed with the bar conditioner, as one of the units, no facing at all was used. Nothing but the one grade of sand which was uniform throughout the entire mold. The new sand added was reduced from 50% to 10% and the bond consisted of fire clay and water only. In addition to this the grinding of casting surface was reduced to about one-fourth that done under the old arrangement.

It is obvious that the Pan Mill will never fit into the continuous method of sand conditioning. It is intermittent in its action, as it must be charged with a batch of untreated materials, the whole mass then milled and then conditioned batch of sand discharged from the mill.

The Paddle Mill shown in Fig. 9 is arranged for mechanical charging and discharging, but is still a batch mixer, since the raw ingredients must be padled over and pushed back and forth to mix them. In the arrangement shown, although the sand may be fed in by a conveyor, it cannot function as a continuous conditioner since the discharge gate is in the center. To be continuous the movement must be for all the material to pass from one point to another point and all the material go over the same route in order to receive the same treatment and to be uniform.

Even in the Pan Mill, there is no assurance that all the sand will be milled. A considerable amount of sand is carried around on the plows, allowing the possibility of hard lumps of silica, clay, etc., to fall into the discharging sand and hence be carried to the mold. These unmilled lumps of pure silica or clay are fatal to the casting, and are the cause of many rejections. Again I have seen the plows become worn on the front edge so that the sled runner on the underside—by reason of the wear, ride over a layer of the sand on the pan bottom, leaving portions that were not milled at all. The trouble was eliminated in this case by throwing away the cast and substituting rolled steel plates in their place, but before this a lot of unmilled sand had gone through the mill.

Flask Fillers

Another type of sand-handling unit in use is the flask filler. It consists of a storage bin for holding sufficient sand to cover more or less long periods of operation, together with a distributor for taking the sand from the bin and placing it in the flask. It is of particular advantage where the sand is conditioned, put up, and stored during periods when the molding machines may be shut down, or where the shaking out is very intermittent.

Due to the bridging effect of the conditioned sand, gravity alone will not serve to get the sand out of the bin. The rotating disc feeder is one method, the reciprocating drag is another, the bucket conveyor is still another.

Am showing two types of motor-operated flask fillers, one with rotating disc feeder, the other with, what the manufacturer terms, a sand distributor.

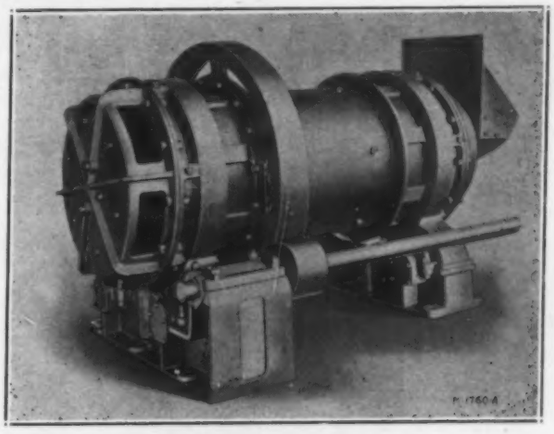

FIG. 12.

Fig. 13 shows one of two flask fillers, each serving one molding machine. The bin is a circular steel tank open at the top, where it is filled, tapering off at the bottom in the form of a cone, the entire weight of the bin, with its sand, is carried on the surrounding structural framework. This was built by the local construction department of a steel foundry in Ohio, in force at the time, in conjunction with the C. O. Bartlett & Snow Company, of Cleveland.

On the center of the revolving disc, a small cone is mounted, which projects about 18" up into the cone of the bin and hence into the sand; also there is a space of three or four inches between the surface of the disc, and the bottom of the bin. As the disc revolves, the small cone attached to it, loosens the sand, causing it to feed down towards the opening; the space between the bottom edge of the bin, and the base of the small cone is only a few inches so that the loosened sand feeds out onto the disc. The band supported on the bottom of the bin and close to the surface of the disc restricts the outflow of sand to the volume desired. The plow, shown at the left, scoops the sand off into the small bin at the base of the boot elevator, from whence it is dumped into the gated hopper directly over the molding machine.

The hopper, it will be noted, is fitted loosely over the upper schute and is counterweighted through a toggle mechanism at the bottom. After a certain weight of sand has fallen into the hopper it overbalances the counterweight; the hopper lowers a little, which trips a switch and shuts down the drive.

It will be noted that the disc and boot elevator are driven by one motor, the boot drive being through two belts. The disc is gear driven; a spur gear is mounted horizontally on the disc on the under side; the motor shaft also in the horizontal direction transfers the driving force to this spur gear through a self-contained gear reducer. The reducer can be seen on line between the motor and first pulley. Considerable trouble was experienced with these reducers, and in fact with the whole drive; the arrangement

is very poor for inspection and repairs, and serves to illustrate the absence of forethought in considering how the repairs were to be made. Arrangements were being made to change the application, permitting the motor to be moved, and arranging the main spur gear to be of a radius nearer to that of the disc in order to reduce the tangential strains at the periphory of the gear.

Aside from this, the flask filler proves to be a successful unit. In this type of unit, sand feeds out of the bin over the disc slower than it is discharged

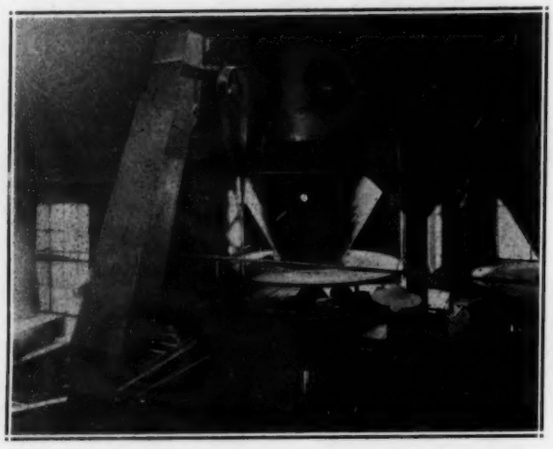

FIG. 13.

from the hopper into the flask; this requires that sufficient sand must always be in the hopper to fill the flask and which is in turn renewed by the disc, and boot elevator. It might be possible for the schedule of the molding machine such, that the alternate filling of the flasks, then jolting and removing them would require that the disc operate continuously. On the other hand, the schedule could be such that the disc fed faster than the machine required the sand, at which time, the disc would shut down upon the hopper filling up.

Fig. 14 shows a direct distributor flask filler serving one molding machine. The bin is an octagonal steel tank which tapers towards the bottom; open at the top, and arranged so that a portion of the bin is below floor level.

The unit consists of the octagonal storage bin, which is filled with the conditioned sand, and the inclined sand distributor, which is in the nature of a bucket conveyor.

In the operation, the distributor, which is set in one face of the bin, takes a continuous ribbon of sand and delivers it to the schute. The distributor takes the sand, not merely as an ordinary bucket conveyor would do, but takes a continuous stream or ribbon of sand simultaneously from bottom and top of the bin. In fact, the movement of the sand is from the entire face of the pile along its entire height. It will be seen that the sand ascending the distributor is in a continuous ribbon of a cross-section equal to the buckets that go to make up the distributor; the teeth on the outer edge of the buckets can be seen just at the surface of the sand stream. The volume of sand that the distributor could deliver to the flask can be assumed when considering the cross-section of the sand stream or ribbon shown in the view, and the speed at which the distributor might be operated.

The distributor operates only while sand is being discharged into the flasks; for few seconds only—in the operations shown. The motor is push-button operated, and controlled by the operator. It is evident from this that an ample supply of sand is instantly available at the discharge chute at the will of the operator.

Sand will feed into the distributor as long as there is any left in the bin. While the distributor is operating, the bin is being rapped by a vibrator fixed to one side of the bin. The whole arrangement is highly simplified, rugged and efficient. It can be used in a great variety of applications; as a flask filler serving one or more molding machines directly; as a storage bin; as a unit in a sand distribution system, and so on. This flask filler has been improved during the past two years or so, particularly in added strength and rigidity both in the framework of the distributor and in the chain of cast steel buckets that go to make up the moving element. The drive has also been improved.

Heretofore it was considered that all conditions were satisfied when a supply of sand was available for filling a flask from a storage bin or hopper and with the amount of sand that flowed into the flask left to the judgment of the molder. If more sand than necessary was used, spilling the excess on the floor, it was shoveled back into the flask or into the flask of the next mold.

This is being done away with to some extent and in the past, some niceties for measuring the sand have appeared. In one installation, a hopper is arranged directly under the overhead bin. It rests on one leg pivoted near the floor and connected to a reciprocating disc, and with a bin shut off which is held back by the hopper. When the measured sand is to be dumped into the flask the reciprocating mechanism is operated by the touch of a button, this tips

FIG. 14.

the hopper down, dumping the correct amount of sand in the flask. At the start of the **travel** of the hopper, the shutoff closes the bottom of the bin, shutting off the sand. When the empty hopper is pulled back by the completion of the reciprocating disc's revolution, it again pushes the shut-off back, permitting the hopper to fill again, ready for the next flask. In this arrangement, just enough sand is dumped into the flask for a complete filling.

Measuring is the logical thing, and the future will see its added use. Dumping sand on the floor in-

iects an unknown factor in the time element in making a mold, the sand must be shoveled back into the flask, requiring labor, that could be used otherwise more profitably.

Molding Machines

The molding machine now occupies a most important place in the foundry, and forms a valuable factor in the manufacture of sound castings. Its development and increased adaption in the foundries has been remarkable in the past two years.

In the paper on "Foundry Electrification," read at the Buffalo Convention in 1923, I stated that "the two outstanding features which might be called 'epochal' in the electrification of machine molding which have been brought out in the last few years, are first the Roll over Jolt Pattern Draw Machine, with electrically-operated pattern draw and roll over equipped with electrically-operated run-out car, and second, the sand Slinger." In this connection, have found material to further strengthen my opinion of the two types of machines. Each of them has been improved upon and strengthened.

There are a number of types of molding machines on the market, all of which incorporate certain features for producing the desired condition, that makes the perfectly rammed mold. The three types shown here, however, will serve to illustrate and be typical of the whole situation.

In the Association proceedings of 1923, covering this paper, two types of Sand Slingers were shown; a stationary slinger and a tractor type slinger. One type of the Osborne Electric Roll Over Pattern Draw Molding Machine was shown. By comparing these with the views of the sand slinger and Osborne Electric Roll Over Pattern Draw Machine shown here the improvement, stability and simplification of each will be apparent.

Fig. 15 shows a corner in a steel foundry in middle Ohio, making railway castings principally. It shows two Jolt Roll Over Pattern Draw Molding Machines, which are built by the Herman Pneumatic Machine Company, of Zelienople, Pa.

The Herman machine is in reality two machines; first a plain jolter or bumper, and second, a roll over with an equalizer, the two occupying separate foundations. The flasks are clamped to the roll over table by bolt clamps or by clamping cylinders, which hold the flask to the table by air pressure.

The two units shown are alike except for size, the one in the foreground being the smaller of the two. The locomotive wheel center patterns in the lean-to in the background will give you an idea of the work handled on the two machines. The larger of the two machines, that at the left with the table rolled over, handles flasks up to approximately ten feet square.

In the operation, the roll over table with the pattern fastened to the upside rests on the bumper table, and is free to rise and fall in guides on the ends of the roll overarm trunions when the mold is jolted. The flask is clamped to the table, the facing sand is shoveled in from a box adjacent (shown on the floor between the two machines), then spread over the surface of the pattern; the flask is then filled with backing sand from the bin overhead by pulling down on the counterweighted gate by a handle, which can be seen just above the nearest machine; the sand feeding out of the back side of the gate instead of the side visible in this view. The table is now jolted until the sand is compactly rammed. The table is then rolled over by the swinging upward and backward of the roll over arms, in conjunction with the fixed arm pivoted at a point between the roll over arm pivoted point and the table. The view shows this fixed arm with a turn buckle on it in an inclined position in the far machine, which gives an idea of its pivoted location. The other end is shown in the near machine, also in an inclined position attached to the trunion guide arrangement on the

FIG. 15.

table. This will give you an idea of the turn-over action.

After the table has been rolled over, it is in the position shown in the far machine, except that the half mold is still clamped to it. The equalizer (shown in front of the near machine) is raised by air until the equalizer cross bars—those with the knife edges, press against the under side of the flask, thus equalizing the pressure; the clamps are now loosened and the equalizer slowly lowered away from the pattern until it is in the position shown in the far machine. The table is then rolled over and lowered onto the bumper to the position shown in the near machine when the process is repeated. The half mold on the equalizer is then lifted off by the half gantry crane shown directly above the far machine and laid on the floor, where the cores are later placed and the mold closed.

The view shown is a part of the main foundry at the lower end. This main bay is served by five cranes on the main runway, one of which is shown just above the half gantry crane. There is another half gantry crane, a duplicate of that shown here, farther up the building in the same relative position and serving molding machine also in the same relative position.

The molding machine, while referred to as a pneumatic machine, is not entirely so, the roll over mechanism is hydraulically operated—a straw oil being the medium used. There are a large number of this type of molding machines in general use in the industry. It occupies a strong position in the field, and before the situation finally settles down to an electrical one, this machine will have to be reckoned with. From experience with the machine, I see no reason why the roll over and the equalizer pattern draw could not be operated electrically, thus vastly

simplifying it, without altering in any way, the basic principles of the machine.

Fig. 16 is an Osborn Jolt Roll Over Pattern Draw Molding Machine and run-out car, arranged for electrically operated roll over, pattern draw and electric run-out car.

The machine is the same type as that shown and discussed in the electrification papers at Buffalo; a comparison of the machine illustrated then and now, will give you a definite idea of the improvements that have been made, all of which have been in the

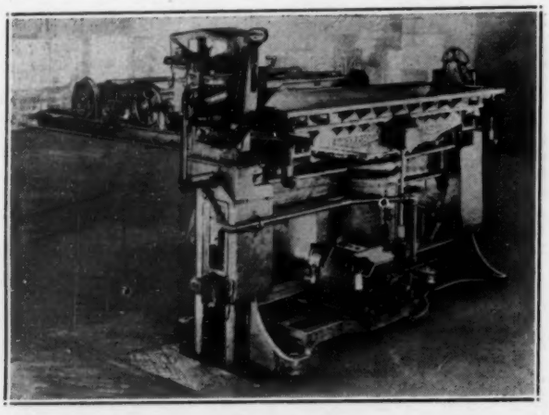

FIG. 16.

way of increased strength, ruggedness and stability of operation. The jolt is still air-operated as then. Additional weight and reinforcing of castings; additional guides; increased bearing areas, replacable wearing plates on the run-out car, etc., together with a rearrangement of the motor application and control, are some of the improvements to be noted.

The roll over is direct; the table turns over as it is raised vertically and is analogous to the movement of the old-fashioned self-inking rubber stamp, where the type plate turned over through 180° as the handle was pushed down. The table is stopped by a limit switch at the end of the stroke, all of which is adjustable. The motor-operated run-out car is run under the mold, the table then lowers slowly on to the equalizing mechanism on the car, which equalizes the pressure of the flask now resting on the car, to that which exists in relation to its clamped position on the table, but which differs for each flask by reason of inequality in surface, warps, etc. The clamps are then loosened and the table rises slowly under control of the operator. After the pattern has cleared the sand, the rest of the up-stroke is completed at a faster speed. After the pattern is entirely raised, the car is run out where the half mold is taken care of; the table is then rolled over and lowered onto the jolter and the operation repeated. The control is positive and simple, hence reliable; dynamic braking is utilized in the lowering operation. The stopping of the motors on the run-out car, and on the machine are done automatically. The operator has control of the lift, while the pattern is clearing the sand, but when he releases the button the final stroke is automatic.

The machine is electrically operated in the larger sizes only at this time; are arranged in size to take a flask from approximately 5½ feet to 12 feet in length, and have a weight capacity from 3,000 pounds to 30,000 pounds.

Fig. 17 shows a locomotive type sand slinger which is about the latest development in sand slingers. It is built by the Beardsley and Piper Company of Chicago.

Again quoting from the Electrification Paper previously mentioned: "briefly the slinger consists of a revolving shaft with an electric motor directly connected at one end, and an impeller head upon which is fastened at the outer edge a hand or cup-shape casting is attached to the other end; the impeller head rotating at motor speed, usually about 1200 R.P.M. for iron castings and 1800 R.P.M. for steel castings. At each revolution of the head a lump or slug of compressed sand is slung into the mold at a velocity of from 2,700 to 6,000 feet per minute, and at the rate of 5 to 10 cubic feet per minute.

The unit shown in Fig. 17 is a complete sand preparation and ramming device in one unit, and is used mostly in large jobbing operations. The machine travels under its own power on a track approximately 9 feet C to C. The sand is shaken out between the rails and is pulled into the bucket elevator and conveyor by a screw conveyor and lifted into an oscillating riddle and over a magnetic separator, thus preparing the sand for use. The slinger or ramming arm is secured to one corner of the machine, shown at the right in this view, the bowl-shaped head with hand grip covers the impeller head —the rammer arm is mounted on a vertical support, upon which it turns. The arm operates in a 12-foot radius, and can be raised or lowered to clear flasks of different heights.

A general statement in regard to its capacity would be that the machine would do the work of from 30 to 50 men, depending upon the class of work and kind of support the organization gave. One case

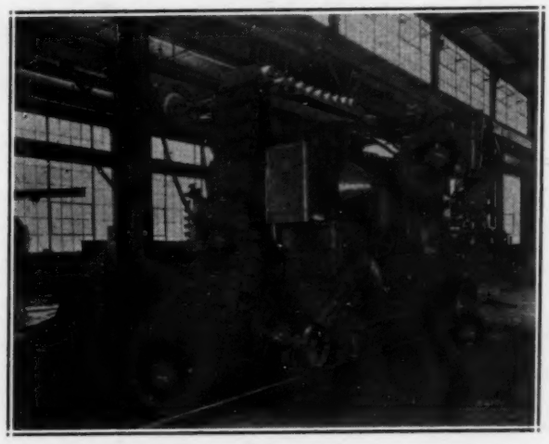

FIG. 17.

is on record where this machine rammed 200 tons of sand in 8 hours.

This machine is in use in a locomotive works in Pennsylvania, on large iron castings. Since the discussion of the machine at the Buffalo Convention in 1923 the sand slinger has been installed in a few steel foundries, under special permit and license.

From my experience with the sand slinger in steel castings plants a few years ago, I would say that a wonderful improvement has been made in both design and application and particularly in its ruggedness. I would say that the future development of

this type of the slinger will be to operate in conjunction with the plants' sand handling and conditioning system—which will be to handle, condition and control all the sand in the plant through the central system—and away from the sand conditioning accessories now involved. This machine shown is a young foundry in itself.

Now a molding machine, regardless of its type or make, produces more dependable molds than can be rammed by hand; it invariably tends to spread the sand over the flask area—some better than others.

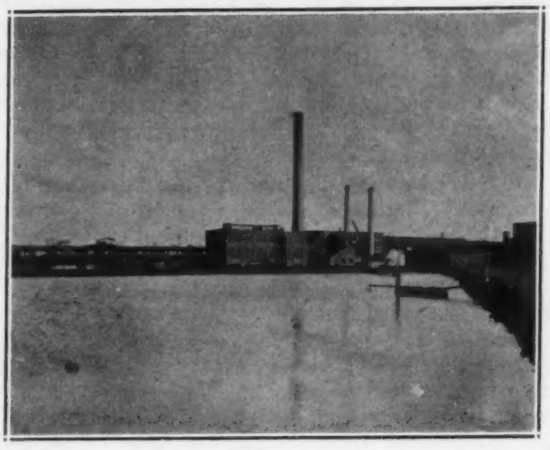

FIG. 18.

The machine which will deliver a blow or jolt over the entire surface of the table uniformly that is; where the table reaction is uniform per square inch of its area—is performing one of its most important functions. A jolt without rebound, ever so slight, is another important function.

The machine should be of the simplest construction possible that will permit the mold being rammed to a uniform density per square inch of flask area; permit the pattern to be drawn without the aid of external hammering and permit the mold being taken from the machine in the shortest space of time. It should be of such construction that it can be kept permanently leveled to prevent sand drifting; which is a most serious source of trouble in machine molding.

The electrical machine should be kept as simplified as is consistent with continuous operation. It is an easy matter for the designer to put a hatchway switch on this side for some purpose, a contact breaker on the other side for some other purpose, a brake on the motor, etc., but he must not lose sight of the fact that every attachment—no matter how simple—that is added to the machine, injects a potential source of trouble and delay into the normal operation of the machine. Simplicity should be the aim at all times. I have learned this by bitter experience.

Power Plant

The foundry is gaining every day in importance as a user of electric power. Heretofore the amount of electrical applications in the foundry, as compared to air applications, were small and usually the foundry had its "Power House" with a small, noisy engine and generator and one or more steam-driven compressors, with an attending antiquated boiler house. Conditions have changed during the past four or five years and these relics of a past era are rapidly disappearing.

I am showing here, however, one of the most efficient power stations that it has been my good fortune to see outside of the steel mills. It is located in a steel casting plant in middle Ohio. Fig. 18 shows the cooling pond in the foreground, and the power house building in the background, also the stack serving the boilers. The small two-story frame building directly to the right of the power house building contains a "Wayne" water softening and purification plant. The boiler house is directly back of the power house and not visible in this view. The barometic condenser shown at the power house, just to the right of the locomotive, was built by the Ingersoll Rand Company of Detroit.

Fig. 19 shows a portion of the main floor of the power house. There is a basement below covering the entire area of the building, which is a very good feature.

The first unit is a 230 volt 500 K.W. Westinghouse Turbo Generator with a gear reducer. It is equipped with continuous flow oiling system and water-cooled bearings. The next is a 300 K.W. unit direct connected to a Skinner Uniform Engine. The next two are Ingersoll Rand Direct Engine Driven Air Compressors. In addition to those shown in this view, there is a 400 K.W. unit direct connected to a Hamilton Corliss Engine, making a total of 1200 K.W. In operation, the turbine is able to take care of the plant requirements, when they are slightly under plant capacity. At capacity and over, the Skinner Uniflow unit is operated in parallel with the turbine unit. The Hamilton Corliss is a spare unit entirely. It is operated only when the turbine is shut down for cleaning or minor repairs on Sundays.

Located in the basement, are the usual auxiliary units. The condenser, water circulating pump, the dry air pump, the pump for pond return water, a pump for cooling water for open hearth doors, reversing valve, etc.

The switchboard is along the wall opposite to that shown here. The distribution cables are carried to the foundry under ground.

In the boiler house B. & W. Sterling boilers are used, together with Murphy stokers under two boilers and a B. & W. Chain Grate under the third, or spare boiler. The coal is dumped into a chute outside under the car, from whence it is carried by conveyors to the crusher and the overhead bins, from whence it is fed by chute direct to the stokers. The ashes are handled by an ash car and conveyor to car outside.

From the time the coal leaves the car until the current is delivered to the foundry, every unit is of the most efficient obtainable even to the size and height of the stack.

In the face of this, the most efficient isolated power plant, I have come in contact with, I must again reiterate the statement made at the Buffalo Convention two and a half years ago in the Electrification Paper that "A foundry is intended solely for the purpose of manufacturing and selling castings." When it enters the field of the manufacture of power, it takes over an enormous amount of troubles, worries and trials which attend this branch of manufacture and in addition, is compelled to compete with a highly developed business in the conversion

of heat into electric power by the Public Service Corporations."

Must again say that the last leg upon which the foundry man has left to stand, is the contention that he has complete control over the power supply and possible interruptions therewith; that the possibility of being caught with a heat hanging on "the hook" is

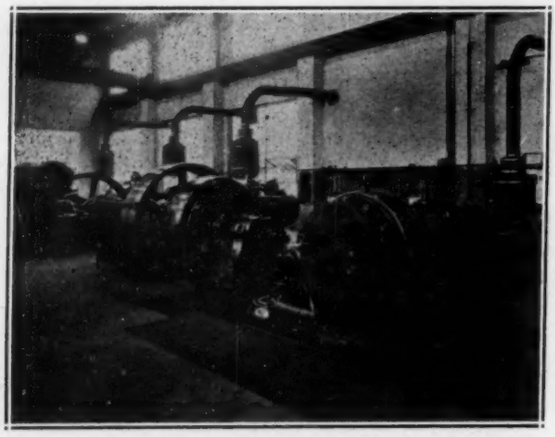

FIG. 19.

under his control alone, and not upon the element of dependability of an external power supply outside of his control.

Lighting

One very serious defect in the ordinary foundry is improper and inadequate lighting that obtains, throughout the industry in general, both in the artificial lighting by electrical units and the natural lighting by daylight through ample glass areas. Foundries in general are the poorest lighted of any of the manufacturing industries, even those of lesser importance than the foundry industry.

It is true that the problem of illumination in the foundry is one of the hardest to be met with in the entire field, but this is only a detail. It is true, also, that molders in general have been accustomed to work in an atmosphere of gloom, dust, smoke and with every object and material with which he came in contact of a color that was black or very close to it; therefore, he expects little of anything else.

But first the welfare of the worker, second the precision of his work, and third his ability for production must be considered, therefore, like the best of modern manufacturing plants, the illumination of the foundry must be brought up to the best obtainable both for the benefit of the worker physically, and for the improvement in production.

The research work at Nela Park in the field of illumination indicates that a workman must be provided with the proper lighting of his work in order to do his best. That better vision enables him to see better the details of the work he is doing, thus automatically permitting the eye to more quickly follow the working cycle with greater precision, so that accuracy is naturally the result. The better the illumination, the quicker and clearer the image is registered in the eye, which increases the rapidity of vision and hence eliminates lost time in registering details.

It is only a few years since 3 foot candles was considered good inside illumination in industrial plants, but study and research has proved beyond doubt, that this should be increased, so that now 10 foot candles is considered good average working intensity, and from this up to 20 foot candles is in use in manufacturing plants, depending upon their nature. Think that an intensity of around 10 foot candles should be maintained throughout the foundry.

The research at Nela Park has brought out a number of characteristics in the effect of illumination upon the eye and its ability to perform its function under working conditions. That good vision requires more than mere perception of an object, it requires the discrimination of its fine details. The speed with which this discrimination can be accomplished, or in other words, the speed of vision involves all factors of light and lighting which influence the ability of the eye to distinguish details by difference in brightness.

Figure 20 shows a foundry arranged for good illumination, the clearness of the details speak for themselves. It will be self evident that lighting of this nature is of the highest order, and production of good results. This is a typical "High Bay" illuminating arrangement that shows excellent distribution.

In foundries in general it is not a hard matter to determine what mounting scheme would prove the best. The foundry is usually a symmetrical bay or bays of uniform size; one typical type in extensive use is that of a central bay with a monitor and with a lean-to on each side, the lean-to being high enough for a crane runway. The best arrangement is where the units are spaced symmetrically throughout the building. This should apply in all bays, it further permits of extensions throughout the whole plant regardless of the number of bays or buildings.

Upon planning a lighting system, it is of the utmost importance that the wiring in all of its branches—copper, conduit, switching, etc.—should be adequate for both present and future needs. It has been agreed upon the best authority that when the calculations to cover the needs of the installation under consideration, including usual overload are made that they should be doubled; wire of twice the carrying capacity; switches of twice the rating and conduit large enough to take this double size wire. Changes in type of reflector or size of lamps may be then made with ease, but where the spacing of the outlets are too great, or the wiring and conduit are adequate for the present needs only; satisfactory results can never be gotten without costly and troublesome alterations.

This has been one of the most serious troubles met with lighting development and while discussing it with the lighting industries most successful pioneer in Commercial Lighting Engineering, was enabled to agree with him most heartily.

The mounting height of the units above the working plane determines the maximum permissable distance between outlets. Too great a spacing will cause unevenness of illumination and heavy shadows. To get good illumination units should not be spaced more than 1½ times the mounting height above the place of work. Where there are crane runways, it is usually advisable to stagger the units, in order that the floor area directly under the row of units will not be darkened to any great extent, as the crane travels along. The approximate floor area covered

by the light from each unit should be computed and the lamp size determined. An average of two watts per square foot will give, in most cases, the size of lamp per outlet.

All reflectors should be kept clean, the opposite of which is almost universal practice in the foundries. Dust-tight reflecting units are recommended; one type is a porcelain enameled steel reflector with a wire glass cover plate which prevents the collection of dust and dirt on the reflector and presents one easily accessible surface for cleaning; another type is the prismatic dust-tight unit. For high bay lighting, concentrating type units should be used. All reflectors should be kept cleaned. Can conceive of no piece of equipment more useless than a reflector that does not reflect.

It is not the intention or policy to criticise any of the machines or systems shown herein, but rather to show in as much detail as possible the various methods of performing the same operations or rather, I should say, to bring about the same condition. Without doubt, the manufacturer of each is firmly convinced that his method is the best for the purpose and makes every endeavor to induce the foundry owner to see this also. I wish to say, however, that heretofore, in the great majority of foundries, the influence of the user has been a negligible quantity in the design of machines, but rather the maker has built a machine which he induces the user to apply to his work.

This condition is undergoing a radical change right now. A complete new set of factors have developed, upon which business is carried on—a new era is coming upon us. A new condition that has been developing for a year or two. The maker now looks ahead and ascertains, what are the ideas that the possible user has in regard to the makeup of the appliance, and then gives him what he wants, of course, being careful that it does not become a freak.

Now, the customer, remembering his burned fingers, remembering the grief, the delays, the upkeep costs, the constant labor required to keep the mechanical white elephant on its feet, which was purchased with money he should have paid to the government in excess profit taxes (called inflation, overexpansion, etc.), remembering that this mechanical white elephant must be constantly maintained—a condition that constitutes a mortgage on the plant's production as long as it exists—now holds back until he is sure he sees what he wants. The manufacturer now must make his machine prove its merits, and stand the scrutiny of all interested parties. It cannot be sold now upon advertising alone.

It must be correlated to predetermined standard conditions in the conditioning of the sand, or the production of the mold, which are comparable to those of other machines and also to adopted standards in successful use.

The average man is getting to know better what he wants and is haggling more and more to get it. He has practically been on a buyer's strike during the past year and a half. He does not buy until he has fixed his gaze and his attention upon the thing he wants, and has gotten the opinion of all those who will likely be interested in and who also have fixed their gaze and attention upon it. Then he looks and thinks again, perhaps he can find something more simplified and dependable.

His fingers will smart from the burns he has received. His toes are bruised and a few of them crushed by the white elephants he was induced to buy, by the potent charm of the claims, and broad assurances made by the sales representative and of the ready cash from the war's huge profits. Now, the things that interest him are: will it produce more at lower cost; will it run longer without need of replacements; will it operate with less attention

FIG. 20.

and maintenance; what is the value of its factor of reliability and so on?

We may think that all the inflation and over expansions of war times have been liquidated, that all these mechanical mistakes have been rectified, but I want to assure you that they are not, that considerable liquidation is being carried on right now and with considerable yet to be made.

I know plants that are completely surrounded by machinery which is complicating the upkeep problem and inevitably must be rearranged, rebuilt and most important of all—simplified.

These are a few of the factors that are being worked out in this foundry readjustment that is in process of evolution now.

Wastes and Losses

Electricity is the moving force of the world. It is the most flexible and most economical method of taking energy from one place and delivering it to another. It has made great strides in the past five to fifteen years, but is still only an infant, in its effect upon the advance of civilization. The development of electrical applications during the next ten years will exceed all that which has been done heretofore.

You know the number of heavy operations that were formerly performed by hydraulic units with their attending delays, troubles and griefs. I ask you now how many hydraulic or steam drives of any nature are incorporated in the steel plants of recent construction? You know that it is a rarity to find these antiquated methods now.

The crude methods existing in foundries today—some of them the most important in the United States—would appear almost shocking when compared with conditions in a modern steel plant. They will be weeded out, however, and in their place simplified equipment will be substituted. The waste

in lost production plus the enormous upkeep costs will force this change or else they will put the plant into bankruptcy.

The steam hammer is doomed, though its substitute is not quite in sight. This is up to the big Electrical Houses rather than to the present builders of steam hammers. They necessitate an isolated boiler plant and at best they are wasteful steam users. Such alibis as the steam can be used for heating in the winter; that they can generate their own electricity, etc., are always available on short notice, but they cannot save the hammer.

Recently there has been installed in a Cleveland Steel Foundry, an Electrical Warm Air Heater. This electrically heated air is circulated by a fan, the whole arrangement—heaters, fan, switches, etc., in one self contained unit. This type of heater is highly economical—heat is generated and circulated; it is always under control; when the plant air temperature permits, the switch is pulled out, the unit shuts down, and any loss that existed stops instantly. This knocks one leg or prop from under the steam hammer.

As the steam hammer is affected by the use of an inflexible expensive operating medium, so is the air jolted molding machine. It requires also an inflexible expensive operating medium; expensive first—in the conversion of electricity into compressed air and second—in the enormous loss from air leakage. While investigating conditions in one of the largest steel foundries in this country, we found this leakage to be 30 per cent of the total air compressed. These uneconomical and inflexible practices will eventually cause the abandonment of the Steam Hammer and Air Jolt Molding Machine and the Air Hoist. I might also say that just over the horizon there approaches the substitute for the Air Hammer, Air Rammer and the Air Vibrator.

The losses from preventable wastes in the foundry are stupendous, both in material and in labor, all of which have become accepted as standard practices in the industry.

The expenditure on flasks reaches enormous figures in some foundries, resulting first—from the multiplicity of types and sizes of flasks used, and second—from the terrible abuse they receive in handling, particularly in shaking out where no mechanical shake out apparatus is used. Upkeep costs on flasks resulting from breakage and bending of the parts reach almost unbelievable heights.

Another frightful loss in the foundry is the refuse or waste sand; not only the actual throwing away of the sand, but also the cost of trucking and disposal. All foundries have waste or refuse sand; the Steel Foundries the most. There will, without doubt, always be some sand to throw away, but the difference between what could be called normal waste, in an average steel foundry that is now possible, with the modern equipment and methods today, and what is now actually thrown away, would show a vast different in volume, an almost incredible difference.

But just mention to the average manager or executive that his amount of refuse sand could be lowered, that the amount of new sand that is daily being put in could be lowered, thereby bringing about a corresponding reduction in the waste sand and observe the effect of the statement upon him.

Just what is refuse sand anyway? How many times may a grain of sand be used for molding, before its usefulness has ended? In just what condition is it, as compared with its original condition, when it must be thrown away? How do we arrive at the knowledge and by whom? The average Steel Foundry Executive could not give you a comprehensive reply, particularly if samples of the waste sand in question were to be submitted to chemical analysis and physical tests. He does not have the information to do so. His reply would not be based upon research and statistical information, but rather upon the imperical information, or the opinion of the Superintendent, or Foreman. The actual deciding point now is that amount of new sand that is added each day to the system, when a like amount of used sand must be disposed of to make room for it; part of this waste sand may have been used only once.

At the rate that we are putting new sand through the mills, it is only a matter of estimate to show how often the entire sand pile in the foundry is replaced. In comparative records as to new sand used in the plants of a large steel foundry concern; one of the plants during one month was able to reduce it to 600 pounds of new sand per ton of castings. The manager of this plant did considerable bragging over this record. In the Steel Foundry industry a ton of new sand per ton of castings is considered average practice.

Now just think what this waste means in money and effort; transportation to the molder; laborious handling and disposal of the waste sand; the cost of the new sand and so on. I would venture to say that conservatively it amounted to $20.00 per ton in the end.

The Phantom foundry, known in the industry as the "Hillside" foundry, is one of the "funny" spots met with in discussing new installations. This foundry is to be constructed on a side hill and arranged so that the new sand will be delivered on the uphill side, while the waste goes down the dump on the down hill side, thereby requiring no storing or hauling. Seriously the foundryman who was enabled to find a building site with a deep depression or gully on it was indeed considered fortunate. He had a handy place to throw his waste at about $20.00 per ton.

The loss due to avoidable labor costs are enormous. In one case in the steel foundry shown in Figure 3, it required 3 men 9 hours per day to prepare the plant core sand, and as it was an 8-hour shop 1 hour each day per man was overtime. After the new continuous sand handling system was installed, it handled all the molding sand that was needed in the foundry for the entire day in 4 hours. After this, it was shut down. During one of these periods of shut down, the system, up to and including the continuous mill, is operated on core sand. It is enabled to condition all the core sand required for two days, while operating 1½ hours every other day, using two men. This was a reduction of labor from 162 man hours per week to 9 man hours per week; it amounted to a saving of $76.00 at 50c per hour, or 10 per cent on an investment of $39,000.00 This is in addition to the increased reliability; an assurance of no loss of time by any failure in the supply due to shutdowns that had occurred in the old system; and finally, the saving in floor space formerly taken up by the old system. No special mill is required for core sand. This is simplification.

In another case of two steel foundries; one in Ohio and one in Pennsylvania, each having the same tonnage per month, rating, each the same number of cranes, each producing the same castings for the same trade, there were 19 stationary drive motors in one plant, while there were 65 in the other. There was also a proportionate difference in labor, repair costs and investment costs.

One of the greatest needs in the foundry industry today is the simplification of the highly complicated flask situation that exists. The foundry must standardize its flasks into a restricted number of sizes and types and then stick to these. After doing so, they would be justified, even in refusing business, because the castings in question could not be fitted to any of these flask sizes.

The constant making of new flasks, repairing and altering old ones, the transporting, shifting, storing, fitting to molding machines, etc., of the large number of flasks in the average steel foundry is one of the heart breakers that must be faced by everyone interested.

In addition to the complications in the storing, moving, repairing and rebuilding of flasks, there is the necessity of keeping in a serviceable condition an enormous number of them, in the plants where a half or a whole day's production of molds must be laid on the floor before they are poured. In a number of plants I have come in contact with, a special flask rebuilding reserve in cash must be set aside each month in addition to flask repair costs.

The continuous foundry would eliminate a lot of this loss and expense while the use of smaller melting units in batteries, if necessary, would eliminate a lot more. Standardization which will be with us in a short time, will finally reduce it to a few per cent of that now existing.

Design

One of the most serious faults to be found in the average foundry equipment, is the pernicious practice of installing light, flimsy equipment, buildings, supporting frameworks for sand apparatus, cranes and runways, conveyors and elevators, etc. The first cost is low and the engineers are prone to look at it from the design and construction side, entirely neglecting the upkeep side. An absence of uniformity, rigidity, and stability exists in general; ruggedness is noticeably absent, though it is discussed and claimed by makers and designers of foundry equipment.

Past methods of doing things in the foundry were so crude and laborious, that any method of doing them mechanically seemed so far advanced in comparison, that the mechanical method and apparatus appeared in the light of something phenomenal. The apparatus as used might actually be trouble breeders and be built without foresight as to its effect upon service and upkeep costs.

In the purchase and construction of light complicated types of sand systems, there appears an absence of caution in first, deciding upon the nature of the equipment; second, the effect of its action upon plant operation; third, in practicing foresight in being assured that there is no better or more simplified system or method obtainable for doing the work, and fourth, in thoroughly investigating the method that is going to be used in making each replacement in the various parts of the system.

After it is built it is then "the machine;" it is put forth and defended as the solution of that problem. How the replacements and repairs are to be made, or what delay-breeding details the "machine" may incorporate, have been given no consideration. The master mechanic always takes care of repairs and if the "machine" breaks down, it is his hard luck.

The light bucket elevator previously referred to—when the buckets pulled off the belt at times, thus wrecking it—is typical of this situation; an elevator was an elevator, the buckets pulling off might be unfortunate, but it couldn't be helped. Heretofore, these factors have not been considered, they being looked upon only as inherited faults in all machinery and were to be expected. Little thought was given to the measure or degree of insurance that the machine could be depended upon to give continued uninterrupted service.

The factors that should have controlled the design of the machine were neglected. The factors of safety, dependability, accessibility and repair costs are the four most important in deciding what system or method or machine should be used. No single factor equals dependability; after this comes accessibility and speed of replacements, with safety always considered. Dependability and accessibility are vastly more important than efficiency and first cost. Efficiency alone, that is, the actual time taken to perform the function for which the machine is intended, has been given too important a position in its application.

Have seen an inclined flight conveyor, handling sand from a shakeout, wrecked twice in less than four months. It was a chain drive of long light links operating over sprockets at each side, top and bottom. In service, the links stretched a little each day under load, thus gradually increasing the pitch, while that of the sprocket remained the same. A time would come, while an unusually heavy drag was being lifted, when one of the sprocket teeth, which were long, engaged under a roller at the joint of two links, instead of passing up between the rollers and through the link, thus literally pulling the conveyor to pieces. It was necessary to shut down that part of the plant, which was one of the largest steel foundries in this country, while the conveyor was being rebuilt.

ELECTRIC HEAT

Melting Furnaces

A few years ago, we had a number of different types of melting furnaces for melting steel and nonferrous metals. Each was sponsored by some individual who manufactured and marketed his furnace as the logical successful melting unit for melting steel for castings.

We had single, two and three-phase furnaces. We had one, two and three upper electrode arc furnaces. Some with water cooled electrodes in the bottom of the bath, and some with a monolithic conductive hearth and with an electrical connection made therewith. The intention of each was for the power to pass out through the bottom electrode or connection, thus furnishing the necessary circulating currents which that particular sponsor stated was necessary to the successful melting of electric steel. Then, we had the induction furnace, wherein the

bath was a narrow trough containing the metal to be melted and which formed the short circuited secondary of a transformer, with the current and hence the heat generated within the metal itself.

We thus had furnaces that produced some peculiar condition within itself and in the metal, that without which, the metal could not be successfully melted, and when a possible purchaser presented himself, each exponent of the various furnaces began campaigning to sell that furnace.

The foundry owner was then suddenly confronted with all these different makes and types of furnaces, and with the different methods of melting. He was obliged now to make a decision and select a furnace from the batch of propositions before him, and was obliged to depend entirely upon the canvass put up by the salesman and upon the enthusiastic opinion and description held by each man for his own furnace.

None but the rosy hued side was shown to the prospective, the blue side being entirely hidden and its existence not admitted. The crepe hanging was done later on in a number of cases.

The prospective then made a decision and purchased a furnace almost entirely upon a gamble; without adequate investigation and without an analysis of all the factors which had been tabulated and balanced and compared against each furnace. This has been the cause of a lot of failures with its attending grief and its bad effect upon the electric furnace situation in general. Out of 10 or 11 melting furnace installations in Cleveland alone, only three are in operation at this time. They represent every method of melting both in steel and non-ferrous metals. The non-ferrous metal situation is unusually bad in Cleveland. Out of 5 installations covering arc, resistance and induction furnaces not one is in operation. One of the main troubles being the misapplication, due to lack of knowledge of the situation on the part of the purchaser; inadequate investigation; an absence of help or advice from the outside. One successful furnace will not offset one failure.

Against this gloomy picture, we have operating in continuous service the first and oldest unit in the city. It is in addition to this, one of the oldest in the steel casting industry. Between 16,000 and 17,000 heats have been taken from this furnace, and it still has the original shell, mechanism, winches and holders in use. It is a one ton Heroult located at a Steel Castings Company's plant in Cleveland, and is their sole metling unit. All the castings ever made by this concern in two different foundry locations have been melted in this furnace.

The owner states that the current consumption was about 600 K.W. hours per ton, and the electrode consumption about 14# per ton. When asked if he would ever go to converter practice, he replied "No."

Heretofore, we had a variety of types and makes in existence. The Heroult with three upper electrodes equidistantly spaced, being what was considered the standard; we had in addition among others, the Moore, the Snyder, the Ludlum, the Greaves-Etchell, the Booth, the Vaum Baure, the Seimens & Halske—the latter an induction furnace.

The Moore was and is now a Heroult type furnace except for an added feature, a neutral connection at the bottom of the furnace shell to handle unbalanced currents, I have in mind a Moore furnace that has had the switch in the neutral circuit put in only once in 3 years, so we can neglect this connection.

The Snyder had two upper electrodes of carbon together with one water cooled metal electrode in the bottom of the bath. The roof was arranged to swing back with its electrodes out of the way leaving the top of the furnace open for charging; something like the lid of a coffee pot.

The Ludlum was eliptical in shape with three upper electrodes in a row, with a door at each end and with a mast rigging. Otherwise, it was similar to the Heroult. It had a non-conducting hearth.

The Greaves-Etchell's furnace with two upper electrodes of carbon and with a bottom electrode connected to the monolithic conducting hearth when hot. The furnace was, like the Snyder, two or three phase, when three phase, one leg of the transformer secondary was in each of the two top electrodes, the third leg in the bottom electrode circuit.

The Boothe was somewhat of the Heroult type with upper electrodes. In addition it was equipped with a carbon electrode arranged on a rig at the door so that it could be pushed down into the bath for the purpose of producing circulating currents in the bath.

The Vaum Baure was somewhat similar to the Ludlum, with three upper electrodes in a row. The furnace was oval in shape and better distribution of heat is brought about by more uniform distance between the arcs and the side and end walls. It was unique in that two phase current was used to melt down and three phase current for refining. Great claims were made for this feature of melting down two phase with the middle electrode carrying about 40 per cent more energy than the other two.

The Seimens and Halske was one of the induction furnaces like the Kjelen and the Rochling-Rhodenhausen. The bath was in the shape of a ring trough which formed the short circuited secondary of a transformer. An enormous current in amperes of just a few volts was set up in the metal itself and the high amperage in the metal furnished the heat for melting and refining.

The steel and iron melting furnaces have now narrowed down to the Heroult type, while the brass melting furnaces have practically narrowed down to two makes—the Geolette Arc Furnace and the Ajax-Wyatt Induction Furnace. Aluminum melting for castings has not had the attention it deserves; however, in southern Ohio, electric resistance furnaces are used for melting aluminum for castings used in an internationally known product in a manner that is and has been satisfactory to them during the past six years.

The mentioning of these few furnaces is intended only to show the radically different methods and special features in steel melting that confronted the purchaser of a furnace for making steel castings alone, and does not cover all the types he had to choose from. From this you can form an opinion of the problem as laid down on the prospective's desk as to what furnace he should buy. The problem, while somewhat simplified over that of 7 or 8 years ago, is approximately the same, that is, the

necessary investigation and analysis of the factors governing the application.

As mentioned, the electric furnace situation in Iron and Steel has been reduced practically to the Heroult Furnace and furnaces of the Heroult type, the various makes differing only in mechanical details, and features extraneous to the furnace proper. When the electrodes are down, and the current flowing, the action is practically the same for the different furnaces. It devolves upon the purchaser to integrate between the special features and detail of each.

The Pittsburgh Electric Furnace Corporation "Electromelt" Furnace (The Moore Furnace) and the Wm. Swindell and Brothers' Furnace being the two most popular in this type and service. Another

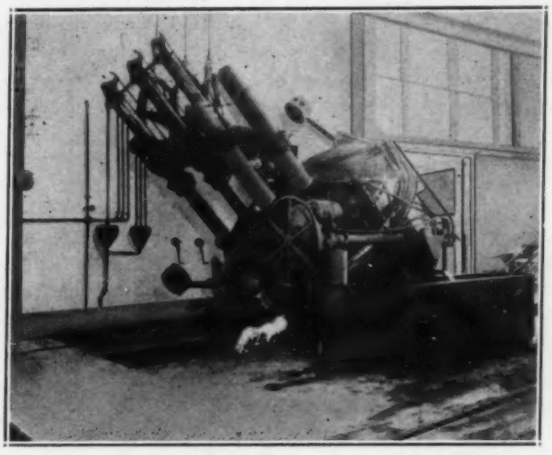

FIG. 21.

furnace has been announced and advertised known as the Gibney Furnace, but no facts or data or information as to its performance are available.

The Moore Rapid 'Lectromelt Furnace, like the Heroult, is circular in shape with an arched roof and a spheroidal bottom. The electrodes are equidistantly spaced and grouped together in the center. Lower operating costs, rapidity of melting and overload capacity are some of the outstanding features claimed for this furnace. Under operating costs, the performance of a 3 ton per hour steel melting furnace in a Southern Ohio City over a period of a year was—average current consumption 485 K.W. hours per ton; average size of heat 5½ tons; average electrode consumption 5.44# per ton; and the average production 648 tons per month. The furnace operated on a single turn basis. The makers state that it is not to be construed that all furnaces are giving as good performance as this. It depends, to some extent, upon the operation and the handling it receives.

Figure 21 shows a 1½ ton furnace in use in a Steel Foundry in Eastern Wisconsin. A "Moore 'Lectromelt" furnace, built by the Pittsburgh Electric Furnace Corporation at Pittsburgh, Pa.

Figure 22 shows two 1½ ton furnaces of the same type in use in a Ship Building Plant in Eastern Pennsylvania making gray iron castings used for Deisel engine cylinder liners and castings that have to withstand ammonia pressure. The manufacturer claims very favorable results from this and other installations for gray iron. In this installation shown, one furnace had operated for about a year on gray iron castings just mentioned, when the other furnace was installed on the same work, but operating on gray iron exclusively.

The furnace operates on two voltages, one for melting down and the other for refining. The transformer is arranged with 9 voltage taps so that a proper voltage can be secured for any desired condition.

The electrode clamps are heavy copper castings with tubes cast inside for water cooling. The electrode holders and masts with the electrodes assembled therein, are an integral part of the furnace and are tilted with the furnace. The doors are specially counterbalanced and remain in any position without being hooked up in place. A special charger

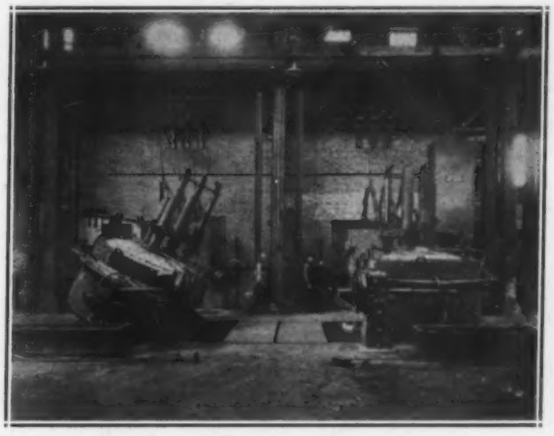

FIG. 22.

in the shape of a long trough or scoop in which the charge has been placed is used for charging the furnace. This is lifted by a hoist or crane and dumped.

The following gives one day's operation of a 3 ton furnace in a Central Ohio Steel Foundry. It covers the operations of this day only which happened to be one observed. It was a haphazard selection of a day's melting and had no special significance. It just happened to permit of continuous observation throughout the day. The furnace was operating on a single turn schedule, which in this particular day covered exactly 12 hours, starting at 4 a. m. with a cold furnace and pouring the last heat at 4 p. m.

Heat No.	Duration	Weight	Power used	K.W.H. ton
1	4 to 6 2 hrs	6650#	2380 K.W.H.	716
2	6:15 to 8 1 hr 45 min	6520#	2000 K.W.H.	613
3	8:10 to 9:50 1 hr 40 min	6590#	2020 K.W.H.	613
4	10 to 11:30 1 hr 30 min	6475#	1550 K.W.H.	479
5	11:35 to 1 1 hr 25 min	6385 #	1650 K.W.H.	517
6	1:10 to 2:35 1 hr 25 min	6370 #	1670 K.W.H.	524
7	2:50 to 4 1 hr 10 min	4000#	1310 K.W.H.	655

Average time of heat 1—43.
Average weight of heat 6142#.
Average K.W. hour per ton 585.

It will be noted from the above, which is typical of daylight operation in a moderate sized steel plant making miscellaneous castings, that the highest current consumption was on the first heat which was on cold furnace starting up. The elapsed time be-

tween heats which covered patching bottom and charging amounted to 65 minutes total for the day, or an average of 7½ minutes per heat.

The 1½ tons per hour capacity furnace shown in Figure 21, gave an average performance over a period of one year as follows:

Average current consumption per ton 572 K.W. hours.
Average electrode consumption per ton 103#
Average size of heat 3.05 tons.
Average tons per month 485.

The Swindell Furnace, like the Electromelt, is of the Heroult type. It is equipped with three upper electrodes, but without bottom connections. It is circular in shape and with the arched roof. A special feature of Swindell Furnace application is the location of two furnace bodies complete on a turntable arranged so that the electrodes can be lifted out of one shell, the turn table rotated, and the electrodes lowered into the other shell. Immediately before the heat in No. 1 shell is poured, the electrodes are lifted out, the ports closed over, the turntable rotated, and the electrodes then lowered into shell No. 2 into which the cold stock had previously been charged, and the power is immediately turned on. The heat in No. 1 shell is then poured, and the cold charge put into it when it is empty. This eliminates any lost time between heats.

Figure 23 shows a 1½ tons per hour furnace built by William Swindell and Brothers of Pittsburgh,

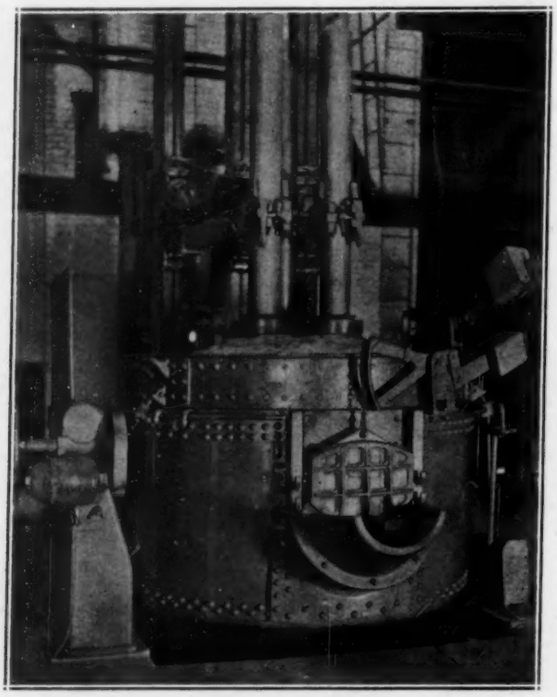

FIG. 23.

Pa. This is a single furnace in steel casting production; the electrodes, like those of the Moore furnace, and other Heroult types are equidistantly spaced and are grouped in the center.

This type of furnace differs radically from the type shown in Figures 21 and 22, in that the masts and electrodes are separate and apart from the furnace shell so that when the heat is being poured the electrodes are outside the furnace entirely with the electrode ports closed over by special lids or dampers. The feature eliminates electrode breakage, as claimed by the makers, due to the rigidity of the masts and that the electrodes are always in a vertical position. The electrode holders are self cooled, being so liberally constructed that water cooling is not required. It is also claimed for the separate arrangement of masts and electrodes that the electrode is supported by a structural steel arm through which no current passes, the current being carried to the electrode by copper busses which carry no mechanical strain; also that as the electrode arms move in a vertical direction only copper ribbons are used for the flexible connections instead of flexible cable, which give a more rugged and better finished construction, etc.

The bottom of the furnace itself is spheroidal in shape, and aside from the special features mentioned, it differs in no way from the other type of Heroult furnaces, the dumping mechanism being practically the same. Two voltages are employed, one for melting down and one for refining.

In general, the current consumption will depend upon the skill of the operator as well as upon the efficiency of the furnace. Economies as low as 450 K.W. hours on continuous acid operation with preheating have been secured and again as high as 800 K.W. hours on a small basic intermittently operated furnace. In the jobbing foundries, the current consumption ranges from 550 to 650. A conservative average for acid operation is 600 K.W. hour per ton.

Severe competition and a more discriminating demand by the buyer is accordingly necessitating a more efficient and dependable melting unit for gray iron. The demand for iron castings made to specification, both physical and chemical, is increasing daily and the insistent requirement caused thereby, for a melting unit that can be depended upon to produce irons of any analysis required, and to do so with dependable regularity in uniformity, at low cast, is continually presenting itself.

The gray iron industry offers far greater possibilities for the adoption of the electric furnace than does the steel foundry industry. The electric furnace is showing already, its wonderful flexibility in first, the grade of stock the metal can be made from, and second, in manipulation of the metal during melting and refining.

In the cupola, we must predetermine the analysis of the melted iron when the cold charge of pig, of fuel, and of the additions is being charged. When it is melted down, we get what we get and this from high priced cold stock.

One important advantage of the electric furnace for iron, lies in its ability to increase the temperature of the metal over that which is possible in the cupola; even with the increase of phosphorous required by the cupola for increased temperature and fluidity. The super-heating given the iron in the Electric Furnace, entirely eliminates the small shrinkage spots that result from insufficiently heated iron from the cupola. This super-heating also increases the density and permits of a grade of castings for high steam pressure not possible in cupola practice.

The phosphorus that must be added to increase, to any extent the temperature of cupola iron, is a most unwelcome contamination in the casting.

While in the electric furnace it is possible to bring the temperature of the iron up to any point desired or required for the pouring of castings of any shape or nature, the only limiting point being that of the melting point of the refractories.

Another great advantage lies in the absence of the pick up of sulphur and silicon which takes place during the melt down in the cupola. In the electric furnace, you put in the charge about what you think it is, take a preliminary test, and accordingly recarbonize with the necessary additions whereupon you can take out metal of any analysis you wish. You can refine it down to and control any of the elements to any condition you wish.

The application of the electric furnace for making gray iron castings is of far greater importance than in the production of steel castings. It is rapidly increasing in favor and has proven successful in every case that can be traced. Its adaption for this grade of melting stands as a possibility of revolutionizing the Iron and Steel Foundry industry, as the same melting unit can be used for both iron and steel castings. It may even be used to make alternate heats of iron or steel. Since the difference between the two types of foundries lies in the melting apparatus together with a slight difference in the makeup of the molding sands, it would be a simple matter to make steel castings in one bay, iron castings in another and with one or more Electric furnaces in between.

In the electric furnace, it is possible to make castings of the highest grade from all cast iron borings. This is an impossibility in the cupola*.

One case of a southern foundry making railroad equipment installed an electric furnace with acid lining and developed a standard practice for making locomotive piston rings, requiring consistent uniformity in the metal with high transverse strength and resilience. In addition, the castings must be uniformly machinable for production manufacture.

The castings which were made from all borings after a standard practice were not only of a superior grade, but were melted more cheaply than was possible in cupola practice as per the following table as quoted—being the average of a month's run:

	Cost	Per ton
Iron Borings	$6.00 per ton	$ 6.00
20# Petroleum coke	10.00 per ton	.10
25# Ferro silicon	70.00 per ton	.88
7# electrode graphite	.18	1.26
3% metal loss		.18
Electric power (619 K.W.)	.015	9.29
Bottom Repairs		.38
Melter labor	1.30	1.18
Helper labor	.60	.40
Labor to charge		.20
Depreciation		.78
Total per ton		$20.66

The cost of cupola iron for the same product over a period was $34.50 per ton of metal melted. Showing an increase of approximately $14.00 per ton or 70 per cent in cupola melting over that of the electric furnace. The current consumption exceeded that for steel due to the fineness of the borings, and the myriad of small dead air spaces in the charge.

A 3 ton per hour Moore furnace is in use in a plant located in St. Louis, manufacturing high grade piston rings, pins, bearings, etc., where some remarkable results have been obtained. The furnace has been in use for about six years, pouring approximately ten tons per day in two heats. The furnace can be charged up to 5½ tons per heat.

These people produce in this foundry nothing but individually cast piston rings with a cross section of about ⅛ of an inch square, and a developed length of about 12 inches. As they are practically casting wires, and to do this and produce a machinable casting requires an exceptional grade of metal.

They say that with all the elements in iron controlled to the most desirable degree, they have always had the oxygen factor to fight when making small castings—a small percentage of oxide making a small casting hard when it would not be noticed in a large section. They are able, with an electric furnace, to finish up a heat by reduction to the exact condition desired. They say that 700 K.W. hours per ton is a good average for high grade, high carbon iron. That 1,000 tons is about the life of a roof and lining; that with the same cost system the electric furnace operation costs about $8.00 per ton more than the cupola which is operated in another plant; that this cost is obtained when using borings and other low cost iron scrap.

They are of the opinion that where extremely high grade castings are desired, the electric furnace will be used more and more in the future, but that the extra cost would keep it out of foundries where suitable material can be made with the cupola. I am quoting the Chief Engineer of this concern almost literally.

The electric furnace was used to some extent during the war for the manufacture of synthetic pig iron, but the process has practically been discontinued since. The iron was made from soft steel scrap, borings and forging flashings, etc, the metal was brought up to the necessary carbon and silica content of gray iron, by recarborizers and ferro additions. This iron cannot so easily be controlled as that made from iron scrap. There is an absence of uniformity.

Now on non-ferrous metal furnaces, the condition is a good bit like that in steel melting. It has been reduced down to two furnaces practically, the Geolette Arc Furnace, and the Ajax Wyatt Induction Furnace. In the paper read at our convention two years ago, mentioned in addition—as successful furnaces—the General Electric Company's Smothered Arc Furnace and the General Electric Company's Induction Furnace. Since that time, I am informed that both have been withdrawn from the market, the induction furnace by reason of inability to secure a lining that would withstand the action of lead.

This brings the melting of non-ferrous metals, that is to say, brasses and bronzes, leaded alloys, and all non-ferrous alloys except aluminum, down to the arc and induction furnace, due to the economies and not from any other cause.

Pointed out in the paper two years ago that the great disadvantage in the induction furnace and that which killed it for steel making was the inability to put in a successful lining in the furnace; that the induction furnace was the ideal electro-thermic, be-

*From Foundry Vol. 53 No. 16 8/15/25.

cause the heat was generated immediately within the metal, which is the proper condition.

In the steel furnace, they were obliged to ram or bake in a lining at a temperature lower than that of the steel itself; in other words, it was necessary to use the steel to bake in a lining and therefore they could not hold the lining in the furnace. Of course, the pinch effect existed in the steel furnace and gave trouble also.

One of the great troubles in the manufacture of leaded alloys and non-ferrous metals is the tendency

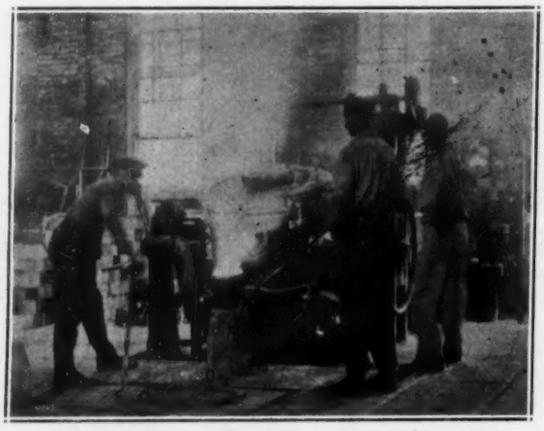

FIG. 24.

of the lead to segregate out, or rather to infiltrate through the interstices of the brick and go clear through to the bottom of the furnace.

These two induction furnaces, the General Electric and the Ajax-Wyatt, each have had trouble with their linings by reason of their inability to withstand the action of the lead in melting leaded alloys.

One of those furnaces, I think the General Electric, the shell of the lining was made of more than one piece; the lead filtered through the interstices at the joints and caused the abandonment of the furnace.

Figure 24 shows a 60 K.W., 600 to 700 pounds per hour. Ajax-Wyatt Induction Furnace, for melting brasses and bronzes; built by the Ajax Metals Co., of Philadelphia, Pa.

The Ajax-Wyatt Furnace was enabled to successfully melt only yellow brass for a long time, but only within the last week, received a letter from Mr. Wyatt, and among other things he says: "We have made some preliminary experiments with aluminum, iron and steel, and as they were first attempts the results cannot be used to draw any definite conclusions. The furnace has been successfully melting red brass, which is 88-5-5-5; that is, 88 per cent copper, 5 per cent of tin, lead and zinc; and other leaded bronzes for approximately one year. The lining for the furnace melting the high lead alloys is a pre-formed and pre-fired block. Apparently the manufacturer has overcome the difficulty previously encountered in melting this type of alloy. The block is sufficiently refractory to stand up under the high temperature conditions; is chemically inert to the attack of lead and sufficiently dense to prevent leakage of it through the walls. This is made of one piece; therefore, in the region of the highest temperature no joints exist." This is one great disadvantage of the induction furnace that has been finally licked.

The final disadvantage in the induction furnace lies in its inability to remain cold over night. Either all of the metal must be poured out of the furnace when it is shut down at night and hot metal from some external source charged into it in the morning to form a ring for the secondary, or else some power must be left on all night to keep a sufficient amount of metal in the furnace hot for the ring. If the power is turned off and there is metal left in the furnace, one of two things will happen; either the shrinkage will break the ring of metal, interrupting the circuit for starting up, or it will crush the lining, which interferes.

In the use of the electric furnace for melting aluminum, it is invariably the custom to consider some form of a holder for the metal such as an iron pot or a crucible which in all cases injected into the situation the losses and wastes which are directly due to the use of a holder. A crucible is not necessary, in fact, in the aluminum melting installation previously mentioned they melt the metal directly on the hearth of the furnace where they formerly used crucibles in coke fired tilting furnaces. Now, while the current consumption in melting aluminum is high as compared to that of brass and bronze, being in the neighborhood of 700 to 750 K.W. hours per ton of metal melted, the difference in specific heat and gravity accounts for the most of this, but the concern where the electric furnaces are in operation just referred to, found upon their own investigation that the metal could be melted for something like 70 per cent of that in their combustion furnaces. They also found in melting their own stock under test that the control of temperature in the Electric Furnace, as compared to what they had been accustomed to, was a revelation to them. Melting a test heat during which their engineer manipulated the electric furnace himself, the metal was melted at a temperature around 1400° which remained about the same, due to the latent heat of fusion. When melted, a test casting was poured at about 1425° the electrical input was not changed and the temperature climbed from 1425 to 1700 in less than ten minutes. Another test casting was poured at 1700°. The two test castings were cut and their surfaces polished, the one poured at 1425° was sound, while that poured at 1700° a few minutes later was porous.

This tricky action in temperature after melting has been the source of an enormous lot of rejections in the aluminum foundries.

Annealing Furnaces

There is a growing demand for the electric annealing of steel castings. It is only a few years since all that was necessary to anneal a steel casting was to drop it in a pit, throw some coke on it and let it burn a while; show some scaling and the customer was satisfied. We have gotten away from that and into the combustion furnace. In combustion furnace practice, particularly in the small steel foundries, little care was taken to produce uniform temperatures, and the cars of castings coming from the annealing furnace varied all the way to 300°. At that time no attention was paid to the effect of the air upon the hot castings immediately after being pulled out of the furnace, that is, the hardening effect.

Now by reason of the closer specifications demanded by their customers, a number of the foundries have gone to the electric annealing furnaces and the demand is steadily increasing. Annealing furnaces are arranged with three radically different types of heating elements. There is the flat nichrome ribbon with which you are all familiar. There is a "T" shaped grid cast from a special alloy and mounted vertically in rows in the furnace. Then there is the round resistor known as the "Glow Bar" made up of some kind of carbide composition, perhaps silicon carbide which has a negative co-efficient of resistance and becomes conductive as it becomes heated.

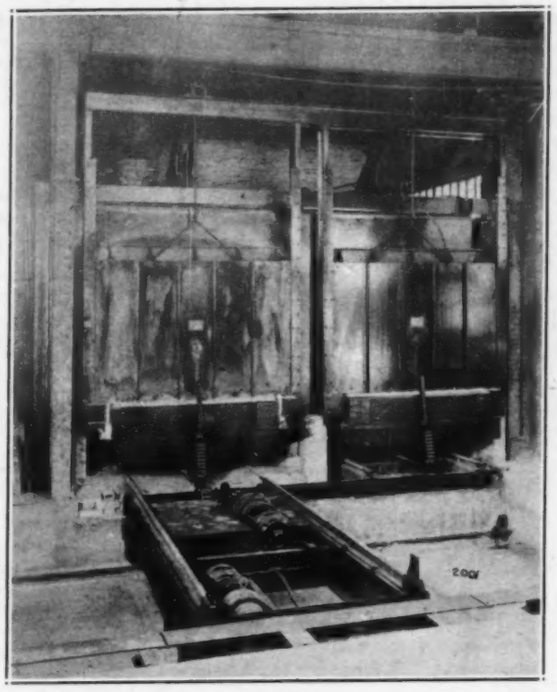

FIG. 25.

Figure 25 shows a late Bailey car type double chamber annealing furnace with two furnace bottom cars, and a motor operated transfer car equipped with motor operated rack puller mechanism. The furnace chamber is equipped with "T Grid" resistance elements. It is built by the Electric Furnace Company of Salem, Ohio.

The furnace is of the two chamber type, both built into the same setting and framework. One chamber is equipped with the heating elements, and constitutes the heating chamber, the other being a cooling chamber.

Figure 26 shows the same furnace with the door of the cooling chamber lifted, showing the car in position. The side sand seals on the car are to be seen. The casting at the top of the door is also a seal, there is a lip across the length of the casting on the back side for this purpose. The furnace is 5½x11 feet effective loading area with a door opening of approximately 3½x4 feet.

In operation, the loaded car of castings in the left hand or heating chamber which has been heated to an annealing temperature and allowed to soak for the prescribed length of time, is pulled out on the transfer car and immediately pushed into the cooling chamber which, on continuous operation, will have a temperature not lower than 600° or 700°. Now when the car of heated castings is pushed into the cooling chamber, there is a fairly rapid drop in temperature through the critical range by reason of contact with the air while transferring and the cooler wall temperature in the cooling chamber. After the temperature has dropped to about 1300°, the cooling is slower as the charge and the walls are approaching the temperature of each other. This gives furnace cooling the rate of which can be governed by a damper arranged in the roof.

This furnace operates electrically with from 250 to 300 K.W. With dense loading the lower figure would apply, and with castings of lighter section and loose loading, the power input may be pushed up to 300 K.W. since the heat can be absorbed more rapidly.

Annealing costs, except in a specific case covering all factors, are out of the question. The manufacturer of this furnace states that with the furnace operating to capacity of 24 tons in 24 hours, it will anneal with 230 K.W. hours per ton or less.

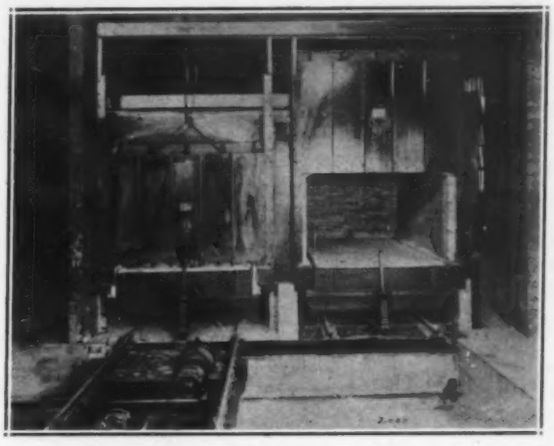

FIG. 26.

The cast "T" grid resistors are mounted vertically and are connected to each other by welding at the surface contacts thus differing from the conventional method of mounting grids by assembling them in a frame and clamping them together by compression at the contact surface. The manufacturer states that there is not sufficient linear expansion in the grid to cause any distortion or to interfere with its mounting in the furnace; that the maximum length of grid is 24 inches, if a longer resistor is required, the grids are double decked.

Like the multitude of opinions and methods of making a mold that exist, there are also a multitude of cycles or systems or processes in existence for annealing castings, and by reason of the various arguments as to what the cycle should be, even by different men in the same plant, no cycle could be used that would be satisfactory to all of them. I have witnessed a number of these arguments, where the proponents of some of them were most convincing in their sound and delivery—just like a high priced criminal lawyer sobbing before a murder jury.

Among the more progressive foundrymen, it is the consensus of opinion that the castings should

go through a modified double treatment—that is, heated, soaked, and air quenched and with a lower temperature heating to produce a casting that is somewhat toughened, but still be machinably soft, and entirely free from strains.

Figure 27 shows a Swindell car bottom type electric annealing furnace for foundry use built by the Wm. Swindell and Brothers of Pittsburgh, Pa. The furnace is equipped with a nickel chromium resistor carried on electric refractory units built into the fire brick lining. The ribbon resistor is wound on the

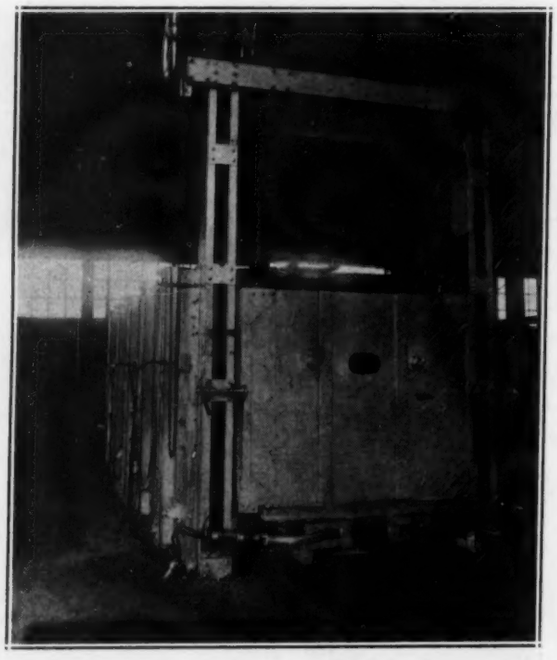

FIG. 27.

refractory hangers in vertical loops along the sides of the furnace and adjacent to the charge on the car. This furnace is arranged with a lift door operated by a hand chain. No information is available as to the performance or the economies of the furnace.

Figure 28 shows a Westinghouse car bottom type annealing furnace in use in a steel foundry in Southern Iowa and built by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. The furnace has an inside dimension of 4½x10 feet x6 feet high; anneals 20 tons of castings per 24 hours to a temperature of 1600° in 6 hour cycles; has a heating capacity of 400 K.W.; the door is lifted by a motor operated mechanism while the car is moved in and out of the furnace by a motor operated rack mechanism.

Figure 29 shows the same furnace with the loaded castings pulled out. A view of the resistance elements can be seen mounted on the side of the furnace.

There is quite a controversy existing among the manufacturers of annealing and treating furnaces as to the method of supporting the ribbon resistor in the furnace. This method of support is a very vital question involving the operation of the furnace, and its adaption. We have one patent known as the Callahan Patent and another known as the Collins Patent. Briefly, the Callahan Patent covers any suitable refractory supporting medium upon which the resistor is mounted, and is very broad. The Collins Patent covers a nichrome pin inserted in the furnace upon which a refractory spool was fitted so that it was free to rotate by the expansion and contraction of the ribbon. In addition to controversy, I believe some litigation is involved between the owners of the two patents.

Some discussion exists as to what is the maximum power or wattage liberation per square inch of surface of the ribbon resistor. One or two say that the maximum permissible watts, that a flat nichrome ribbon may liberate per square inch of surface is fixed and any excess of this amount will cause a breakdown of this resistor. Now this is not true. The wattage liberation per square inch is a function of the surface or skin temperature of the ribbon. It is the maximum permissible ribbon temperature that governs the maximum power liberation. This temperature is fixed at 2,000°. It is possible to have furnace conditions where the temperature in the ribbon, under working condition, permit a liberation of 19 watts, while 13 watts would be the maximum at another temperature and 7½ watts would be the limit at still another temperature and so on up to the maximum permissible temperature of the ribbon.

Another point of discussion and a very important one is the proper spacing distance between the loops in the ribbon.

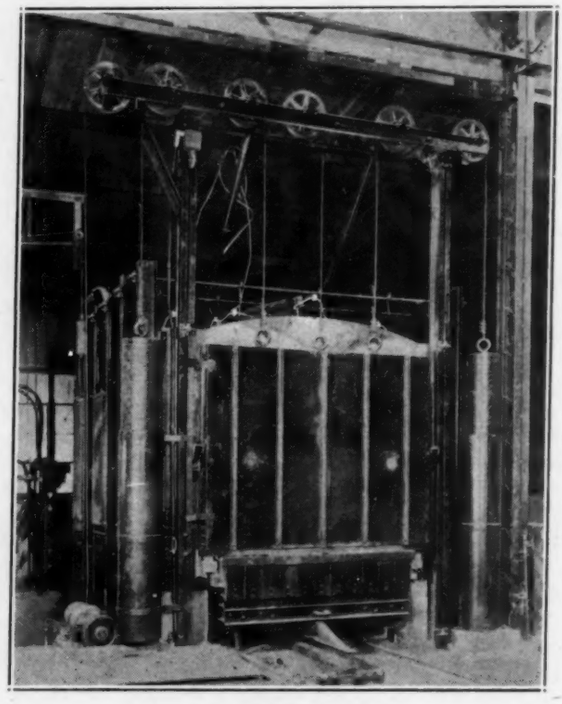

FIG. 28.

Now, the questions the purchaser of an electric furnace—regardless of the application—is interested in the most are: will the furnace operate continuously and uninterruptedly as a production unit and will it produce the results for which it was installed satisfactorily and uniformly. In order to assure himself that it will do this he must consider all the factors that enter into the matter. This has been the main trouble in the past—improper investigation.

While discussing the investigation of electric heat treating furnaces with an Engineer of an Automotive Plant in Cleveland a short time ago, he stated that they had a small electric furnace in which they were experimenting to find out if it would be possible to do their heat treating in an electric furnace. They were going to make their decision on that.

I told the gentleman that he was wasting his time, that this factor in the application of the electric furnace had been fixed for some years; that

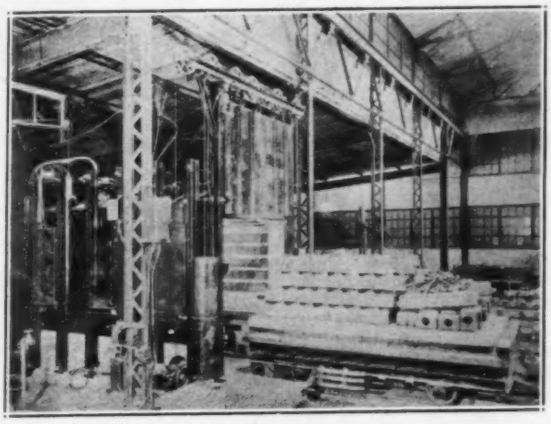

FIG. 29.

there was no heat treatment possible with the uniformity that could be produced in the electric furnace; that anything that could be produced in the laboratory furnace could be produced commercially under any cycle desired; but that there were other conditions which we run into independent of the ability to accurately carry out the cycle metallurgically, that affected the situation. That the furnace must not only produce satisfactory heat treatment, but it must, above all, and which is most important, it must do it continuously and uninterruptedly during their manufacturing schedule day and night, and at certain intervals to be shut down for overhauling, cleaning and inspection, after which it is put back to work again. That this is the problem with which he is confronted in the adaption of the electric furnace, and not will it anneal and heat treat, but will it do it continuously, that was the point. That if it was necessary to get in the furnace to repair it from a breakdown, it would require from 2 to 3 days to cool the furnace sufficiently to work in it, which would disarrange the production schedule. That two of the most vital points in which he was interested were the voltage under which the furnaces were to operate and the nature of the control that was to be applied.

There are in use two general methods of controlling the electrical input, hence the temperature of the furnace. First, the delta-star with or without on-and-off switching method with the current taken directly from the line or through transformers—and second, the variable secondary voltage method with the current to the furnace furnished by transformers, and the furnace voltage—hence the power input, controlled by variable transformer secondary voltage.

Have some very fixed ideas based upon experience as to which of the two methods is the most dependable, but do not think it advisable to discuss them here.

Core Ovens

The baking of cores in a foundry is a serious matter. The finished core when placed in the mold must be uniform in shape, in degree of hardness, in surface condition and baked to the proper degree. An over baked core will crumble and hence change the inner shape of the casting. An underbaked core will cause blowholes, porosity in the casting and small explosions in the mold—quoting from the electrification paper on the subject two years ago. The necessity for uniformity in the cores is of the utmost importance and to produce this it is necessary that they be baked at just the right temperature, the proper length of time in the oven and with the proper amount of ventilation to carry away the moisture and gasses. In other words, the process must be under complete control in all of its factors at all times.

It is becoming recognized more every day that this control of the manipulations can be brought about in the electric oven only. Went into this branch of electric heating to some extent in the paper two years ago, and the remarkable success obtained in electrically heated ovens since have justified the statements made then.

Like other branches of foundry processes, considerable discussion and argument prevails as to what constitutes the proper baking cycle for different shapes, sizes and types of cores. A great difference of opinion exists now as to what the proper amount of air that is required for ventilation. Have seen core ovens in a number of foundries without any consideration being given to ventilation at all. Since electric ovens have come into use, this important feature is receiving consideration, and it is accepted in some economical installations that 15 cubic

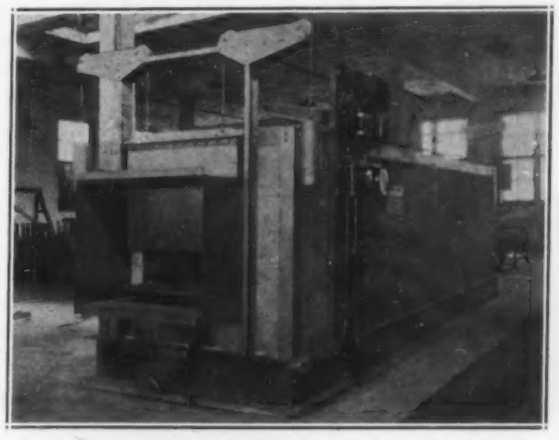

FIG. 30.

feet of free air per pound of linseed oil in the binder is sufficient. Less air is required for other binders. Approximately 65 to 70 cubic feet of free air per 100 pounds of green cores is good practice unless the linseed oil exceeds 5 per cent by weight, when the ventilation must be increased.

Now the positive control of all these factors in the oven, temperature, time, ventilation, etc., that is possible in the electric oven is so obvious that a

little investigation will bring out the oven's inherent superiority.

The continuous core oven is with us now and the remarkable achievements with the one investigated will surely impress the natural advantages, flexibility and positive action of the electric continuous process upon those interested.

Figure 30 shows a Coleman Continuous Electric Core Oven installed this year in an Iron Foundry in Cleveland, devoted to the manufacture of automotive castings. It was built by the F. A. Coleman Company, now the Foundry Equipment Company of Cleveland, Ohio. The oven in this installation is used for drying the pasted and blackened cores before their being placed in the mold. The oven is 26′ 7″ long and 7′ high over all. It weighs, without cover and plates, 35,000 pounds. It is located on the second floor of the plant and arranged so that it can be moved if necessary.

A section of roller conveyor, not shown in this view, is connected at the front door to that in the oven bottom, and another section at the rear door. Cores, which are made in sections, are cleaned, pasted together in a complete unit and blackened, then placed on a plate on the approach conveyor, and pass through the oven at a uniform speed. The oven temperature is automatically held at 450° or an intermediate temperature between that and 500°.

The heating elements are located in the space beneath the roller conveyor, the oven temperature is automatically maintained by pyrometical control. The heated air is circulated by a baby conoidal fan and insulated ducts.

In the old practice, there has been an absence of regulation in the oven temperature, and of the baking cycle. The necessity for complete control of the oven temperature is now recognized, and as formerly mentioned, the absence of this regulation and control has been the cause of more defective cores than any other single cause. In the oven shown, the human factor does not enter into the process.

In this foundry, another late model of the drawer type electric core baking oven has been installed in the last year. It is a double end drawer type, that is, the drawers extend through the oven and may be pulled out at either end. The furnace is of the same type and make as that shown in the paper read two years ago except that a trolley drawer puller is arranged at both ends of the oven.

While discussing the two ovens with the manager of the foundry, he was very well pleased with the operation of both. Stated that the drawer type oven had paid for itself many times in savings of waste by the quality of the cores. Time here does not permit of going into the many advantages of the electric oven, but their investigation will prove their superiority.

Specializing

The foundries that specialize on a limited field in production; that reduce to a fixed number, the types and weights of the castings that will be produced, will come to be the greatest profit producers. In this way, it will be possible for the owner to develop a reputation for quality and reliability in his product not otherwise possible. The limited and specialized field of his production should permit him to develop molding processes, such that the production of a defective casting would be reduced to an occasioned accidental exception to his rule, and then be caught before it could get out of the plant.

By this policy of manufacture, the owner would be enabled to set up some highly valuable talking points in the sale of his product. He would now have something to sell; something to capitalize upon instead of—as in the case of 90 per cent of foundries now—so many pounds of steel or iron or brass made from a certain pattern for a certain price and in competition with a multitude of other foundries of the same type, clamoring for the same business at just a little lower price per pound.

The owners of this latter group of foundries cannot go into the purchasing department of a prospect, submit a price and then stick to it; the purchasing agent knows he cannot. He knows that the price is competitive, and that the salesman has a lower one to which he will go to get the business; but there is an enormous amount of business in existence upon which the purchaser is willing to pay a premium for the assurance that the castings will be sound, close grained, and true to dimension. In addition to paying a premium, he will stretch a number of points to be considered a steady customer of the foundry producing this quality work. He is paying for quality which he has in turn previously guaranteed to the purchaser of his own product.

Confidence in the product, together with the integrity of the maker—which is the most precious ingredient in the product—are the two great and highly illuminated sign boards, pointing the way to the successful marketing and profitable manufacture in the foundry.

I have known the manager of a plant to censure an employe for pouring lead in a crack in a casting, as the casting could rust, thereby exposing the lead. He should know better; he should use something else for the purpose.

Management

In the average foundry today—with its own executive management—there is entirely too much overhead per unit of castings produced; too many non-producers, from the manager to the workman, and from the president to the file clerk; too many executives per ton or per piece cast. This varies inversely with the output. This condition will bring about some very important changes and readjustments during the next year or two.

One of the great requirements in the management is the necessity of maintaining harmony and cooperation among the members of the organization—high and low.

Any infraction of loyalty or any action towards obstruction and prevention by one member of another's duties which would tend to lessen or eliminate the success of his endeavors in improving conditions or carrying out his duties should be met with instant dismissal.

There is an absolute demand for loyalty and integrity and a measure of subordination on the part of all members of the organization in order that it will be a success. Our employers' interests comes first, and there should be a sinking of personal opinion to a considerable degree for the common good.

I have found out on numerous occasions that changes in methods and practices have been considered first in the light of the effect they might have upon the standing of those in charge, and who are responsible for present conditions and last upon the improvement of production or savings in costs. This has a deterrent effect upon initiative in general and is one of the principal factors in the backward condition of the industry.

Another serious trouble is the inability, or unwillingness to change from an existing condition. To be adverse to, or unwilling to try new things is wrong; by trial and change, we learn to do better things, or things better. Let's try it, maybe we are right.

Industry is undergoing a readjustment in general; no stable factors based upon past performance are available. New factors are cropping up. Necessity for unloading old, inefficient methods are most apparent. We must invent new methods and short cuts in molding. Our methods in general are extremely obsolete; they must go.

It is not the volume of business, the tonnage that counts in the end; it is the net profit that is left after deducting all expenses of whatever nature. Therefore, every dollar that we can cut off the manufacturing costs is just that much profit, and upon it depends the life of a great many foundries. The condition that is forcing itself on the foundry is the same as in other industries—the necessity of meeting an increased demand without increasing the cost of output.

The industry is full of tricks, dodges, and subterfuges. One of the tricks is "Passing the Buck," blaming it on some one else, or on some other department. One case in mind: a cold heat was tapped from the furnace and could not be poured into the molds. A day or two later the superintendent of melting, made up a list of complaints, the charger was falling to pieces, the incline mechanism was on the bum, the oil piping was leaking and plugged up; in fact the equipment was going to the devil from neglect, he finally stated in great anger, "You are responsible for that cold heat we tapped the other day." After considerable unprintable language had passed in very loud voices, the melter superintendent cooled down, changed front, and decided not to complain to the president.

Another case in mind: After a hurry-up construction job in the foundry was done during Saturday and Sunday, the foreman of the foundry complained on Monday afternoon that we were careless in cleaning up, as his men were obliged to lug away five empty oxygen tanks that we had left. About a month later another piece of construction work was done in the foundry under similar circumstances; again on the afternoon following the foundry foreman again complained that they were obliged to carry away six empty oxygen tanks after us, that he was getting sick and tired of cleaning up after us. The "nigger's" head appeared above the wood pile, when the man who used the torch, stated that he used only a part of one tank and took that back to the shop when he was through.

The next piece of construction work consisted of putting up some fabricated steel work on the building columns, and setting up a heavy handling machine. Since the fabricated work was done in a bridge shop where we could assume that average accuracy in laying out would apply and since the handling machine was set up complete by the manufacturer, before it was shipped, we decided that we would complete this job entirely without gas cutting of any nature. We decided to drift all holes in line where possible, ream the balance, and if necessary drill any holes with an electric drill. This arrangement was strictly carried out. Some time later the manager complained that the foreman was obliged to gather up all told thirteen empty oxygen tanks, which we had used on this job, that it was first, very sloppy work on our part, and second, we were using too much oxygen. Upon being informed that we had not used a torch on the job, some hemming and hawing took place, and the episode was dropped. This is simply typical of some of the conditions that exist. No empty tanks had been left after the work was completed. It was simply that an exorbitant amount of oxygen was being used and part of it had to be blamed on some one.

It is not amiss for as much as a thousand pounds of cold stock to be incorporated in a ten or fifteen ton heat without its being put on the weight sheet, in order to help out the yield, and so on.

The problems of the foundry will never be solved by mere academic discussion, any more than they will by the constant discussion and argument of operatives of the old school foundry.

There has been too much talk and not enough statistical information; an abundance of opinions and not sufficient research, nor the willingness to profit by what exists. It is the last stand of the old practical molder executive. If he stands in the way of the progressive movement, that is in the immediate future, as I have seen him in the past, he is going to be run over—steam rolled, so to speak.

With the advances that have been made in other industries and the fine start that was made in the foundry industry, we will have developed a manufacturing program here that will not be reached by Europe during our life time. Established customs cannot be broken there as they are here.

It is conceded that the industry here will, however, have to split the profits a little more generously among the working producers in order to keep up and enhance his standard of living, but above all, to permit him to alternately create and dissipate a cash reserve, become a spender, which you will admit is the backbone of our prosperity. He must always have ample coins to jingle in his pocket after the bills are paid and the monthly quota laid away, but brethren he will have to produce.

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Guarding Against the Invisible Hazards of Electrical Installations

By W. GREENWOOD*

WHILE all the matter herein contained is not directly applicable to rules for safely operating cranes, much of it is and all of it is intended to assist the reasoning process that enables us to be consistent as well as make the work complete.

Our subject is intended to discriminate between hazards that are well known and those that are not generally known. Our list may include some that should be well known, but records seem to show they are not or that they are inexcusably disregarded.

Accident prevention has become one of the most active and serious movements of the present age. It was slow in coming but it is here to stay. The things we discuss are well understood by many of us, probably a majority of us, but the trouble has been in failure to get action, and at the present time it lies in not getting full action. The principal reasons are, indifference, overconfidence, ignorance, disrespect, selfishness and blindness. You are left to apply your own reasoning powers to see how they affect the cause. Unless everybody takes an interest in the subject, acts, urges and compels others to act, we are bound to have accidents, and this statement applies to you and me as much as it does to anybody. While we who know what to do try to do it, to some extent we are at fault for the other fellow being ignorant because we do not compel him to do right. The first thing to do is educate, the next is compel, and the tendency of our efforts is toward these two duties. We preach to educate and the codes we make are the laws that must be enforced if they are not willingly obeyed.

In making rules or codes to guide employees in the matter of avoiding accidents we are inclined toward making them mandatory and trust to the power we have for enforcing discipline in securing strict compliance. We cannot, if we will it, take away from anyone the privilege of acting on their own judgment, especially in great emergencies, therefore, we think, mandatory rules, where the hazards may not be readily visible to everybody, should be accompanied by explanatory matter that is educational in order to leave no excuse for failure to obey them. Quoting from an article contained in Trumbull Cheer, a little publication issued monthly by the Trumbull Electric Manufacturing Company, "Do you understand the result you are expected to accomplish or is you work just a mass of misunderstood or not understood detail? There is a difference in the man who can handle a situation and one who can only follow blindly a set of given instructions." The National Electrical Safety Code not only tells how installations should be made but, in cases where the reason for compliance with the instructions might not be fully understood, rules are followed by sufficient explanation to make the reason plain. My suggestion is, rules for safely operating any kind of equipment should be accompanied by a brief treatise describing general principles of construction and operation, so that operators may fully understand why existing hazards can be avoided by compliance with the rules. Generally the published educational information connected with installation and operation of equipment is read only by managers, superintendents or others high in authority. Copies of such publications multiplied by ten, fifteen or any larger multiplier, for distribution among operating employes, would not enhance cost proportionately to the benefits derived.

Our safe-guarding methods for prevention of accidents should not go so far as to lead anyone to think such full protection has been provided by careful inspection and other methods as to remove anxiety in regard to failures that would jeopardize their life. This particularly applies to chains and ropes for attaching loads to hoist tackles; to methods used for protecting employees that have occasion to go onto crane runways. In nearly all cases where injuries have occurred from dropping of loads the victims had too much confidence in the value of attachments and lifting cables. In nearly all cases where employees were injured while on crane runways by moving cranes they had too much confidence in protective methods. We should not do anything that will take away from anyone the idea of mutual responsibility in the matter of safety.

Too much stress cannot be laid on the matter of standardization. Construction for quality, simplifying interchangeability, order of arrangement of control equipment and such other factors as effect cost and safe operation, are never too highly estimated. Where like elements and application of forces are differently assembled with variation in results, and the benefits in particular cases are offset by disadvantages or what might be objections in some kinds of service, standardization does not apply beyond the general principles that are applicable alike to equipment of similar kind. Without this variation in the matter of construction the main factor that sustains competition in manufacturing would be removed.

The hazard connected with grounding and not grounding metal structures or substance through which current can flow, located close to current carrying equipment that is alive, is not so fully understood as it should be by many who are employed in electrical or other work and are sometimes liable to form the contact between live parts and other parts, either grounded or not grounded. Suppose a metal structure or any conductive material, to be so located, as regards distance from live equipment, that a person could form a connection between them with their body then, if the conductive material or structure was grounded, the body would form a path for travel of the current. Again, if the conductive material or structure were entirely insulated

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from the earth, if such a condition can be conceived, the current flowing through the body would be sufficient only to saturate the conductive material or equalize the potential, and would be much or little in accordance with the extent and capacity of the conductive material contact was made with. Interposing non-conducting material between the body and such conductive material as the body may come in contact with will prevent injury provided the voltage does not exceed certain prescribed limits. This explains why the use of rubber gloves, dry rubber matting, wood or other dry non-conducting material is required by safe practice. A little but not enough knowledge of these two principles is sometimes a dangerous thing, because in some cases it leads to over-confidence in the quality or value of insulation, or that insulation is not needed when it is needed.

Working on electrical equipment or electrically operated equipment that was not killed by a method that would positively prevent someone who was ignorant of conditions from closing the circuit or starting machinery, has resulted in many accidents. A high tension circuit might be opened by a foreman to permit of cleaning line insulators, and through error of some kind it would be closed while the cleaners were still on the job. A switch may be opened to permit of working on machinery and while there would be no likelihood of the switch getting closed, through some error it would be, and this would result in an accident as we have witnessed, and the occurrence was as here described. Such occurrences demonstrate the importance of strictly complying with such rules and methods as will positively prevent them. Standard rules for safety should require that the station operator alone should be responsible for opening and closing important circuits, and applying such methods as will prevent himself or anyone else from carelessly or ignorantly closing or opening a circuit where a hazard is involved. A further safeguard would be for each station operator to keep a record of important events or changes that his relief operator would examine at the beginning of his turn. Dependence should not be placed on any method but locking open a switch with a padlock where life or property would be endangered by closing it. The importance of applying such precautions has been pointed out frequently, yet failure to do so too often occurs and bad results follow.

Overtravel limits should perform their office under any and all conditions, therefore they should be so installed they will do so A travel limit for stopping the travel of trolley or other machine that travels on a track, can be so wired it will be effective only when the cut-out device remains closed. The wiring and the brake operating device should be such that, whether the current is off or on, the travel could not extend beyond predetermined limits. The same requirements should be applied to hoist limit devices. The possibility for continuing the down travel of a trolley drum until the cable winds in the wrong direction and carries the block up, without operating the limit, is very great. Sometimes the condition is such that the tackle block will not touch the floor when the cable is entirely off the drum, and when conditions are such sometimes the operator fails to see that the cable has wound on the drum when the drum is traveling in the lowering direction, but he stops the hoist when the block is near to the limit cut-out. He may leave the crane before discovering what has happened and the change operator, being ignorant of this condition, would throw the control for lowering, but the travel would be up and a mishap would occur. When once a hoist limit device is wrecked it cannot be repaired until operating conditions will permit of holding the crane out of service for a considerable length of time, and this may be a week or more.

The importance of so interlocking disconnecting switches with oil immersed switches, where they are installed on circuits of high potential, that the disconnector cannot be opened before the oil switch has been, or that the oil switch cannot be closed before the disconnector is, has not always got proper consideration. It is presumed a qualified operator knows the importance of opening or closing a disconnecting switch only when the oil switch is open, yet there always is the possibility that, through neglect or some combination of circumstances, he may do one or the other if they are not so interlocked it would be impossible, and the result almost invariably is very serious.

Sometimes the generating equipment of a power station is increased out of proportion to the rupturing capacity of the circuit breakers in service. Neglect to properly consider the size and capacity of circuit breakers permits a very serious hazard to generating equipment with attendant hazard to human life. If complete protection for high tension switching is desired, and it should be, every precaution must be taken to increase the rupturing capacity of the present switching even to the extent of installing new switching of the proper size. Another way of accomplishing the same result is to install current limiting reactors for reducing the rupturing duty required of the oil circuit breakers. Whenever the station generating capacity is increased, the amount of power to be interrupted in case of a short circuit, becomes one of the most important factors in determining the type and size of oil circuit breakers to be used.

The hazard connected with operating electrical equipment by persons not authorized, even though they may be qualified, should not be underestimated. It is just as necessary for an operator to understand the methods of doing the work as to know how to handle the equipment. Lack of experience in doing the work is the reason for confusing an intellect that ordinarily may be very keen, and mistakes will result. We know of a case where a man who was perfectly familiar with the construction and purpose of all parts of the electric locomotive concerned, started to haul a ladle car holding a ladle full of iron without seeing that the air brake reservoir was full. The result was a serious wreck occurred and a man was injured. Had this man been authorized he would have been qualified, and being familiar with mill methods he would have tested the brakes before moving the locomotive, since he should have known it was standing idle for twenty-four hours. In another case a man who was unfamiliar with operating methods, pushed an idle crane on a runway and caused a fatality when the crane could have been moved, as was necessary, without an accident. These two cases only are cited from a list that is quite lengthy.

Failure of transformers employed for stepping down voltage from high to low, say from 2200 to 110 volts like that usually employed in lighting circuits, has resulted in many accidents, perhaps many more than was generally heard of. When the induction coils of a transformer on a lighting circuit are brought in contact with each other through failure of the transformer from any cause, then the service lines, supplied by the mains, may carry the full voltage. In a case we know of, a man had taken the precaution to provide insulation for standing on while looking for trouble in a motor, but had failed to open the cut-out switch or rather, had depended on another person to do so, and he was quite severely shocked although he had made but slight contact with the wiring. Another case came to our attention, where a hollow metal pole in a street lighting installation, that contained a transformer in the base of the pole, was knocked down by an automobile and some of the occupants received shocks that proved fatal. It also was brought to my attention such transformers are not always grounded but they should be. Possibly in the case here mentioned there was a failure to do so and this was responsible for the accident.

There is a hazard in disconnecting wires from electrically saturated equipment, like lifting magnets where the wires are attached to the terminals and no disconnector that will permit of opening the circuit without a possibility of contact with the magnet or terminals has been provided. This hazard exists in all magnets in proportion to their capacity. When the current is on they possess a potential energy which, at the time when the current is opened, tends to produce a high voltage at the terminals of the coils. A person might be in the act of disconnecting the terminals on the magnet and not be properly insulated from ground then, if the line switch would be opened at the time when he was in contact with the terminals or any part of the magnet before the current had time to dissipate by natural process, he would receive a severe shock such as has in some instances resulted fatally. The hazard can be avoided by using a properly constructed disconnecting plug, which would permit of safely and conveniently disconnecting the magnet regardless of whether or not the line switch was closed.

To the uninformed there does not seem to be any hazard in storage batteries connected with generating stations, yet there is, not alone to life and limb but there is a fire and explosion hazard. We can cite a case where a man used a lighted match to see the inside of his automobile battery. The gas was ignited and his face was burned by the flame that shot out.

Motor Driven Bloom Shear Without Clutch

By D. W. DEAN*

MOTORS have been applied to shears for some time past, but the shear drive mechanism has undergone little or no change since the days when the shears were driven from a line shaft or by an individual steam engine. The shear is like most motorized applications in that the full advantage of electrification is not secured unless the drive mechanism as a whole is carefully gone over to make certain that features unnecessary with individual motor drive are eliminated.

As usually built a shear is provided with a flywheel, clutch and bull gear. The flywheel presents no serious objectionable features, although adding appreciably to the friction load. To build a clutch which will successfully withstand the severe service of large shears, such as bloom shears, is difficult. In case a hydraulic clutch is used leakage must constantly be guarded against, and in cold weather there is occasional trouble from freezing. The bull gear bearing is very difficult to lubricate properly and is another cause of high maintenance. The cost of replacement parts might be tolerated if it was not necessary to almost completely dismantle the shear to effect their replacement.

Realizing the disadvantages of the customary drive mechanism the engineers of The Timken Roller Bearing Company, when considering the bloom shear for their 35" blooming mill, decided to eliminate the flywheel, clutch, and undesirable bull gear bearing.

*Steel Mill Section, General Engineering Department, Westinghouse Electric and Manufacturing Company.

The bloom shear has a 12" stroke and was designed to shear 10"x10" blooms. A frame 103, 185 HP. (1 hr.), 230 volt, 495 RPM, type MCA, compound wound motor is connected direct to the shear through suitable gears. The motor is started and stopped for each cut, no clutch of any sort being used.

A magnetic controller without current limit acceleration is used, with dynamic braking in the off position.

The approach side of the shear is shown in Fig. 1, and the runout side of the shear is shown in Fig. 2. The "pancake" master switches for the shear approach table, shear, shear runout table, and shear kick off are shown in Fig. 1.

The product sheared is 7"x8" blooms and 8"x9" blooms, rolled on the 35" 3 high blooming mill from a 4200-pound 19" octagonal shaped ingot of electric furnace alloy steel.

An oscillograph test on this installation indicated that properly applied electrical equipment will easily provide sufficiently rapid acceleration for large shear applications, and the peak currents during the cutting cycle should not be objectionable. In fact, on this particular application the output of the shear could be increased by 50 per cent without overworking the electrical equipment.

At the time of the test the shear was averaging 210 cuts per hour.

Table one shows results of the oscillograph tests on this shear. Oscillograph F and oscillograph G

compare the shearing of blooms of different analysis and size. The bloom being sheared when oscillograph F was taken was 78 per cent of the cross sectional area of the bloom for oscillograph G. The average cutting horsepower for oscillograph F is 84 per cent of the average horsepower for oscillograph G. Oscillograph F was taken on a bloom of high carbon and high nickel analysis, and oscillo-

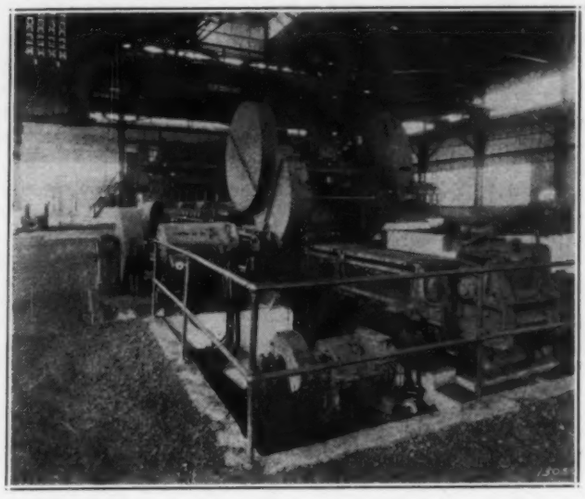

FIG. 1.

graph G was taken on a bloom of low carbon content. This would indicate that the analysis is not a great factor in the horsepower required for cutting if the temperature of the bloom is around 2000 degrees F.

Oscillographs G, H-1, and H-2 illustrate the very considerable effect that the temperature has on the cutting horse-power. A bloom of the same size and

FIG. 2.

analysis was used for these oscillographs. The peak amperes for shearing at 2140 degrees F is 630 amperes, and the peak amperes for shearing at 1700 degrees F is 1470 amperes. To obtain these readings the bloom was delayed several minutes between cuts. The temperatures were measured at the center of the bloom immediately after shearing by an optical pyrometer. The importance of maintaining the highest practical temperature for the shearing of hot blooms is evident from these oscillographs.

Figure 3 shows the shearing cycle for oscillograph G of Table I, shearing an 8"x9" bloom. Time in seconds, armature volts and amperes are shown. The broken line at the top of the oscillograph marks each 20 degree motion of the shear crank.

Figure 4 shows for one cutting cycle: (1) the armature current; (2) the motor RPM; (3) the moving blade position with respect to the stationary blade; and (4) the moving blade speed. The current increase when the moving blade comes into contact with the metal is very rapid, the maximum

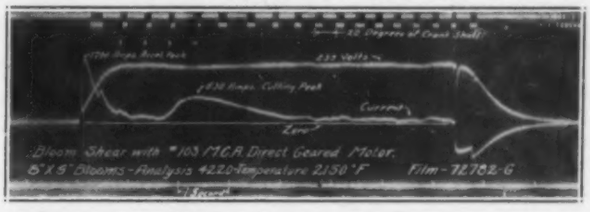

FIG. 3.

value being reached when the blade is approximately 25 per cent of the distance through the metal. The maximum speed of the blade through the metal is not reached until 0.7 second after the current peak. It is probable that the peak current marks the point of partial stress failure of the metal fibres, possibly the passing of the yield point for those fibres which are in tension, occurring when the blade is approximately 25 per cent of the distance through the ingot.

In addition to the effect of the physical behavior of the metal being sheared on the shape of the current curve, two other factors, are important. One of these factors is the change in the shear blade speed which results from the crank action. Fig. 4 shows the shear blade speed. The other factor is

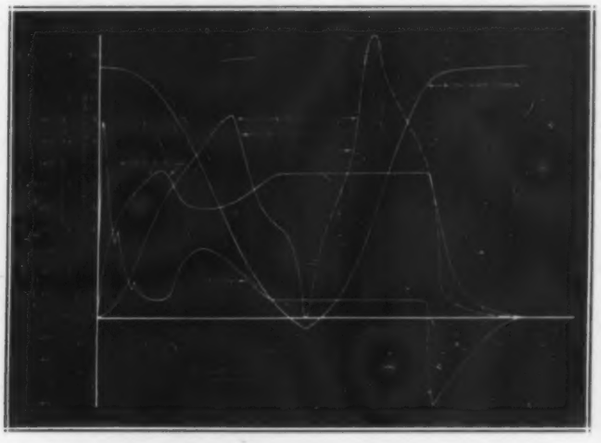

FIG. 4.

the difference in the motor torque required to produce a given downward thrust of the shear blade at different positions of the crank as illustrated in Figure 5.

The sheer is accelerated to the full load motor speed of 495 RPM in approximately three-tenths of a second. The friction load speed for the shear is approximately 770 motor RPM. The motor speed

when the moving blade comes in contact with the metal is 680 RPM. The accelerating current peak of 1700 amperes is not excessive for the 103 MCA motor used. The average motor acceleration while accelerating to the rated full load motor speed is

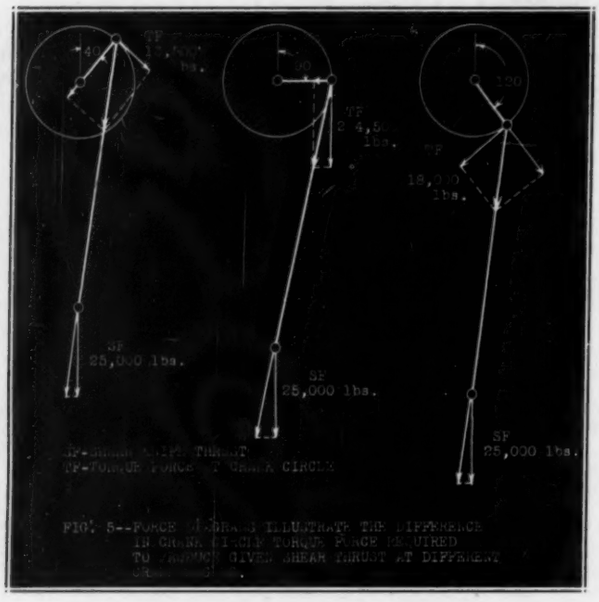

FIG. 5.

1650 RPM per second, and during the entire accelerating period to friction load speed is 430 RPM per second. The shear blade movement before the blade comes into contact with the metal is approximately 2.5 inches. This could be reduced to 1" and still permit the motor to be accelerated easily. Since the starting current is higher than the cutting current there would be no difficulty in starting without any clearance between the blade and bar. All that would happen is the accelerating period would be drawn out longer.

There is approximately 180 horsepower seconds of energy used to bring the shear to the cutting speed. This energy is lost for each stroke of the shear, but it should be remembered that the shear is shut down at all times when it is not required to cut metal. On the other hand a shear using the clutch and flywheel and driven by a continuous running motor is drawing energy from the line at all times, except when it is known that the mill is to be down for long periods of time. The friction load on this shear is approximately 13 horsepower which would be increased by the friction and windage of flywheels to approximately 20 horsepower. It is evident that the continuous running shear would only need to run idle for an average of approximately nine seconds between strokes in order to dissipate the same amount of energy lost in accelerating the direct geared shear.

The direct geared motor driven shear is the most economical proposition from the standpoint of total power consumed and the maintenance cost is less.

It is evident that on shear applications it is entirely practical to eliminate the clutch, a recognized source of trouble, and also the flywheels used with a continuous running shear. The use of a rugged direct current motor, direct geared to a shear presents no difficulty from the electrical standpoint regardless of whether or not the shear may be required to start and stop for each cut.

TWENTY-SECOND ANNUAL CONVENTION AND IRON AND STEEL EXPOSITION

(Continued from Page III)

entertained by the Association in the Louis XVI Ball Room. The cotillion which was presented by one of the large theatrical agencies in Chicago was enjoyed by everyone present. Over five hundred persons attended the entertainment.

Tuesday's program was devoted to Electric Transportation. Mr. O. Needham and Mr. David C. Hirshberger of the Westinghouse Electric and Manufacturing Company presented a discussion covering the Economies of Steel Plant Railroad Electrification. Mr. Needham brought out the fact that the complete electrification of steel plant yards offers very attractive economies and this statement is justified by results obtained in cases where electric locomotives have been used in the mills for special purposes, such as handling of hot coke from ovens to the quenchers, ingots from the soaking pits to the mills, hot metal from the blast furnaces to the open hearth. Mr. Needham also presented tables indicating the investment cost covering narrow gauge systems and investment costs covering standard gauge systems, also, the operating costs covering narrow gauge railroads and operating costs covering standard gauge railroads.

Mr. W. B. Potter, Chief Engineer, Railway Department, General Electric Company, presented a most interesting discussion covering yard switching and mill transportation. Mr. Potter described the Diesel or Oil Electric Locomotive. The author brought out the fact that freight yard switching is being handled very successfully with 60-ton locomotives equipped with 300 HP. engines, and although 300 HP. is considerably less than the power rating of steam locomotives used in this kind of switching, indications are that the Oil Electric Locomotive handles switching more expeditiously than do the steam locomotives having equal weight on the drivers. The larger powered steam locomotives could maintain a greater tractive effort at higher speed than the oil electric, but where this higher speed serves no purpose, the higher tractive effort of the oil electric locomotive within the speeds required for switching presents an advantage. A comparison was offered in connection with the relative fuel consumption of oil electric and steam locomotives in switching service by comparing the gallons of oil with the tons of coal. The records obtained, indicate that 20 to 25 gallons of oil are equivalent to a ton of coal so that with oil at 5 cents a gallon, the comparative cost of fuel on this basis would balance at a dollar to a dollar twenty-five cents per ton of coal. As the oil engine and electrical equipment are com-

posed of relatively small parts, easy to handle and there being no boiler to overhaul, the maintenance of an oil electric switcher may reasonably be assumed as one-half the cost of maintaining an equivalent steam locomotive.

Harold J. Payne, connected with the Society for Electrical Development, presented "How Electric Industrial Truck and Tractor Equipment is Effecting Savings in the Iron and Steel Industry." Mr. Payne's paper brought out the fact that it was necessary to carefully select the type of truck for the particular application for which it was to be used, and that some of the failures which had been reported in the uses of electric trucks were entirely due to misapplication. Some of the points covered in Mr. Payne's paper were, Trucks for Charging Blast Furnaces, Open Hearth Work, Ashes and Scale from Soaking Pits, Handling Slabs of Steel, Uses in the Rod Mill, Handling in Nail and Bolt Mills, Moving Tote Cans and Tumbling Barrels, Forge Shop Practice, Tractor Trailer Method for Tie Plate Handling, Sheet Mill Service, Tin Plate Handling and the Foundry. Mr. Payne also stated that transportation is costing the industrial plants about three billions per year. Many millions of this total are chargeable to the handling operation in the Iron and Steel Industry. By taking full account of the existing methods in the life of available equipment, the present trend toward lower handling cost can be accelerated very greatly. In the progress made, the electric industrial truck is certain to play an important part.

Wednesday, June 9, was devoted to the subject of Refractories, at which time, Mr. M. C. Booze, Senior Fellow, Mellon Institute, University of Pittsburgh, presented a paper covering the subject of refractories for use in steel plants. Mr. Booze brought up the fact that while the problem of suitable refractories is of importance to the Iron and Steel Industry, it is no more so than to the manufacturers of fire brick because of the fact that steel plants and their accessories utilize as much as 50 per cent of all refractories manufactured. As the total production in this country each year approximates 4,000,000 tons and has a value of about $60,000,000, it can be seen that the amount consumed in the manufacture of iron and steel is no small item. Computed on the basis of average life, the cost of the refractories alone is not a large percentage of the total cost for producing steel, when the labor costs and idle furnace charges are also included in the costs for refractories, however, the figure may become an important one. It becomes most significant when premature failure occurs with a considerable loss of production. Mr. Booze's major topics were: Improvement in Quality, Silica Brick, Selec-

General view of Iron and Steel Exposition held June 7th-11th at Chicago, Ill.

tion of Suitable Materials, Fusion or Softening Point, Chemical Analysis, Deformation Under Load, Spalling, Expansion and Contraction, Slag Action, Metallurgical Requirements, and Developments of New Refractories.

W. J. Harper, Combustion Engineer, Donner Steel Company, Buffalo, New York, presented a discussion in connection with Open Hearth Roof Construction. He related his experiences in connection with the application of Roofs in one of the furnaces at the Donner Steel Company, Buffalo, New York. This discussion was intensely interesting to the fuel engineers of the Iron and Steel Industry.

Mr. Martin J. Conway, Combustion Engineer, Steubenville Plant, Wheeling Steel Corporation, presented a discussion in connection with the refractory problem of the by-product coke plant. Mr. Conway presented a very interesting table which showed the classification of refractories for by-product coke ovens.

Mr. F. E. Leahy, Power Engineer, Pittsburgh Plants, National Tube Company, presented a new thought in Gas Producer Operation. Mr. Leahy advocated the adoption of methods of control now in use in modern boiler plants in Gas Producer Operation. The principle points covered in Mr. Leahy's paper were, Gas House Labor, Producer Gas, The Blower, Discussion of Charts that came from Steam Flow Meters and Pressure Recorders, Instruments and Their Use, Automatic Operation of Producers, Effect of Steam on Gas Produced, Gas Temperatrue, Regulation of Steam From Gas Pressure and Furnace Operation.

Mr. E. W. Trexler, Combustion Engineer, Bethlehem Steel Company, Johnstown, Pa., presented a discussion in connection with refractories covering continuous bloom and billet heating furnaces. In Mr. Trexler's discussion, he stated that the fuel engineer would like to see a hearth constructed without any cooling, but built of a refractory material to which the cinder would not adhere and the life of which will compare favorably with the rest of the furnace. The author also felt that the refractory manufacturer should endeavor to develop a refractory furnace skid for furnace bottom on continuous furnaces that will compare favorably with the water-cooled skid pipe. The discussion also brought out the fact that the elimination of water cooling in heating furnaces was important from the efficiency standpoint, as the heat absorbed by the cooling water is from 2 to 5 per cent of the total heat supplied by the fuel.

Mr. A. C. Cummins, Electric Engineer, Carnegie Steel Company, Duquesne, Pa., presented the report of the Standardization Committee. This re-

General view of Iron and Steel Exposition held June 7th-11th at Chicago, Ill.

port will appear in complete form in a later issue of the Iron and Steel Engineer.

Thursday, June 10, Mr. W. P. Chandler, Jr., Special Engineer, Carnegie Steel Company, presented the report of the Electric Heat Committee for the year 1926. The principal points covered in this paper were Arc Melting Furnaces, Induction Furnaces, Resistance Furnaces, High Temperature Applications, Heat Treating Furnaces for Tool Rooms, Electric Hot Tops for Moulds, Roll Heaters, Low Temperature Applications, Electric Heated Tin Pots, Wire Drying and Annealing, Galvanizing Kettles, Babbitt Pots and Electric Arc Welding in the Steel Industry.

Mr. M. J. Conway, Combustion Engineer, Steubenville Plant, Wheeling Steel Corporation, presented one of the most interesting papers of the week. Mr. Conway's paper had principally to do with the Uniflow Engines. The Reversing Uniflow Engine, driving their 35" Blooming Mill, has created a great deal of interest. The complete paper may be obtained in the June Issue of the Iron and Steel Engineer. The complete discussion of this paper will appear in the August Issue of the Iron and Steel Engineer.

Thursday evening, under the direction of Mr. F. H. Kittredge, the annual dinner dance was easily the high light of all of the social affairs of the week. The Dinner Dance was attended by the members, guests and the exhibitors at the Iron and Steel Exposition. The entertainment in connection with the Dinner Dance consisted of high-class vaudeville acts from one of the leading theaters in Chicago.

Friday, June 11, was the climax of all of the activities for the week. Mr. H. E. Davis, Electric Engineer, Interstate Iron and Steel Company, provided one of the most interesting Inspection Trips to the Illinois Steel Company at Gary, Ind., that the Association has ever been privileged to enjoy. Through the kindness of Mr. W. P. Gleason, General Superintendent, the Association and its guests were permitted to visit all of the operating departments of one of the most modern steel plants in the United States. Mr. Gleason provided specially constructed cars with a locomotive and practically every department was inspected. One of the special features was a new power plant designed by the engineering department of the Gary plant, which contained many of the latest developments in Electrical, Steam and Mechanical practices. Luncheon was served by the Illinois Steel Company, after which the guests were conveyed in special machines to the Gary Country Club, where almost 25 foursomes engaged in a golf tournament. Many valuable prizes were awarded. The Illinois Steel Co. acted as a host to the Association in the evening and an elab-

General view of Iron and Steel Exposition held June 7th-11th at Chicago, Ill.

orate dinner was served at 7 p. m. A most pleasing and enthusiastic address was delivered by Mr. Gleason, who related his early experiences in the steel mills with electricity. The chairman of the day's events, Mr. H. E. Davis, was congratulated by the hundreds present at the Inspection Trip and Golf Tournament for the successful manner in which these events were conducted.

General view of Iron and Steel Exposition held June 7th-11th at Chicago, Ill.

IRON & STEEL EXPOSITION

June 7-10th, 1926 **Hotel Sherman** **Chicago, Ill.**

LIST OF EXHIBITORS

Martindale Electric Company
Johns Manville, Inc.
Mutual Foundry & Machinery Company
The Fleig Corp.
Plibrico Jointless Firebrick Company
Morgan Engineering Company
Electrical Engineers Equipment Company
V. V. Fittings Company
National Carbon Company, Inc.
Baker Raulang Company
Robinson Ventilating Company
Westinghouse Electric & Manufacturing Co.
Electric Machinery & Manufacturing Co.
Reliance Electric & Engineering Company
Rollway Bearing Company
The Electric Storage Battery Company
Ohio Electric & Controller Company
G. & W. Electric Specialties Company
Schweitzer & Conrad
General Electric Company
Timken Roller Bearing Company
Norma Hoffman Bearings Corporation
Crouse Hinds Company
Appleton Electric Company
Allis Chalmers Manufacturing Company
Edison Storage Battery Company
Electric Controller & Manufacturing Company
Cutter Electric Manufacturing Company
The Sharples Specialty Company
The Clark Controller Company
Keystone Lubricating Company
Tool Steel Gear & Pinion Company
Republic Flow Meters Company
Railway & Industrial Engineering Company
Electric Service Supplies Company
Condit Electrical Manufacturing Company
The Hayward Company
Green Equipment Corporation
Pyle National Company
Erie Malleable Iron Company
W. J. Jeandron
Cutler Hammer Manufacturing Company
Weston Electric Instrument Corporation
Drying Systems, Incorporated
Trumbull Electric Manufacturing Company
Hyatt Roller Bearing Company
Okonite Company
Square D Company
Crocker Wheeler Electric Manufacturing Co.
M. H. Detrick Company
Bartlett Hayward Company
Pittsburgh Transformer Company
Alliance Machine Company
Economy Fuse Mfg. Company
Chicago Fuse Manufacturing Company
Mutual Electric & Machine Company
Multi Electric Manufacturing Company
McGraw Hill Company, Inc.
Standard Underground Cable Company
Edwin L. Wiegand Company
Bussmann Manufacturing Company
Roller Smith Company
Benjamin Electric & Manufacturing Company
Monitor Controller Company
Chapman Stein Furnace Company
Reed Aid Filter Company
U. S. Graphite Company
The Electric Journal
SKF Industries, Incorporated
Nichols Lintern Company
The Thompson Electric Company
ILG Electric Ventilating Company
Harld E. Trent
B. F. Perkins & Son, Incorporated
Albert & J. M. Anderson Manufacturing Co.
National Air Filter Company

A. I. & S. E. E. Recommendations

Adopted Monday, June 7th, 1926, at 22nd Annual Convention, held in Chicago, Ill., June 7th to 11th, 1926

Covering

Rules for the Safe Operation of Electric Overhead Traveling Cranes*

RULES FOR CRANE OPERATORS

(1) The operator should be examined by a Foreman or someone designated in order that his familiarity with crane parts and their uses, as well as his ability to safely operate the crane may be determined in practice and certified to by the examiner.

(2) The operator shall enter or leave his crane at the designated places, making use of the steps or ladder provided at those locations and having both hands free. All materials too large to be carried in pockets shall be raised and lowered by means of a hand line. The hand line must not be attached to the person of the operator.

(3) No one but the craneman shall be allowed in the cage except for repairs, inspection, or instruction of new men or for safety of men working on the crane runway.

(4) The operator shall keep his crane clean and free from all loose boards, tools, bolts, or other objects which may fall on men below or may cause tripping and falling of repairmen when working on the crane.

(5) The operator should inspect his crane at the beginning of the turn or at least once each shift and report at once, any mechanical or electrical defects. especially noting the condition of cables, limit switches, signal gongs and collector shoes.

(6) The operator shall be responsible for the proper oiling and greasing of his crane and he should report any defects in the oiling system on any part of the crane.

(7) The operator, when about to handle material with his crane, shall devote his entire attention to his work and shall pay careful attention to the following points:

(A) Is the hitch of proper length and is it safe?

(B) Is the signal given by the proper party and does the operator understand the signal? If in doubt he must not operate .

(C) Can the load be carried without passing over the heads of men?

(D) Will load clear all obstacles?

(E) Test brakes by means of a short lift and return of controllers to "off" position.

(F) Allow no one to ride the hook or load.

(G) If craneman discovers men on crane runway, he should stop his crane until proper protection is provided.

(8) The operator shall avoid bumping other cranes on the runway, but if he is ordered to do so, he must move the crane slowly with regard to the safety of men working on or below the idle crane.

(9) The operator must not make side pulls unless ordered to do so by a Foreman.

(10) The operator must be sure that his controllers are in the (off) position and switch opened before leaving the crane, and in case of failure of power the controllers must be immediately set in the "Off" position.

(11) In case a controller sticks the operator must pull the main switch at once.

(12) While repairs are being made to the crane, the operator must stay on the job and help with repairs. If ordered to remain in the cage, he must not operate any motion unless he is told that every one is safe.

(13) When the operator is inspecting, repairing, or lubricating his crane, the main switch must be locked in the "off" position.

(14) In case of a fire on the crane, the operator must use the fire extinguisher provided and must notify the Foreman, who shall see that the extinguisher is refilled promptly.

(15) An operator must not operate his crane if he is not physically fit to do so. He should report to his Foreman at once.

(16) The operator must signify his understanding of these rules and must realize that they are intended to help him safeguard the lives of his fellowmen.

RULES FOR FLOORMEN

(1) Floormen when signaling to the crane operator must use the approved crane signals and above all, they must be sure that they do not confuse the operator.

(2) Floormen must be responsible for all slings, chains and hooks and for their proper use in order to make safe hitches, bearing in mind the capacity of the slings and of the crane.

(3) Floormen shall be sure that the crane trolley is centered over the lift in order to prevent swinging of the load.

(4) Floormen must adjust the slings and chains so that they will not strike men on the ground when the crane is moving without a load.

(5) Floormen shall not ride the hook or load or permit others to do so.

(6) An extra man should be in the crane cage to warn the operator when men are working on the crane runway except where approved track torpedoes are used.

Items of Interest

Roller-Smith Company, 233 Broadway, New York, has issued a new Bulletin No. 550, covering their new type SR line of relays. These type SR relays supersede our old Imperial type relays, and have many marked advantages over the old type. The scales are longer, the accuracy is much greater, the torque has been increased several times and the new 7½" round pattern style of case matches our Type SA and Type SD lines of indicating instruments. Complete technical details are given in the bulletin. The Type AB relay shown in this bulletin is **not** a new one. A copy of this new bulletin may be had by writing Mr. G. L. Crosby, V. P. Sales, Roller Smith Company, 233 Broadway, N. Y.

The Rowan Controller Company announces the appointment of Mr. C. S. Cavitt as their Pittsburgh district manager. Mr. Cavitt formerly was with the Electrical Engineering and Manufacturing Company.

Mr. Wm. P. Chandler, Jr., has resigned his position as Special Engineer for the Carnegie Steel Company, in order to join the organization of the American Heat Economy Bureau, Inc., in charge of the Open Hearth Department.

Mr. Wm. P. Chandler, Jr., received his engineering training at Cornell University and entered the steel business in 1910 at the Clairton plant of the Carnegie Steel Company. In 1917 he resigned the position of steam engineer for this company to take care of the combustion problems of the Cleveland Furnace Company. In 1918 he became assistant fuel and experimental engineer of the Duquesne works of the Carnegie Steel Company, and was appointed engineer for this plant in 1922. During 1924 he was appointed special engineer for the Carnegie Steel Company in charge of fuel and combustion problems.

Many of our readers will be undoubtedly interested in the announcement that, effective May 15, Harris & Butler, Manufacturers' Agents, located in the Real Estate Trust Building, Philadelphia, Pa., have been appointed district managers for the Philadelphia territory for Packard Transformers.

Mr. J. B. Harris, Jr., and Mr. W. C. Grew will concentrate on handling Packard Transformers in that territory.

Mr. L. A. Roberts, formerly superintendent of Maintenance Alloy Division of the United Alloy Steel Company, Canton, O., is now affiliated with the Clark Controller Company of Cleveland, in the capacity of sales representative in Ohio territory.

Mr. L. W. Egan, formerly special engineer for the American Steel Foundries, is now connected in the capacity of sales representative with the Clark Controller Company of Cleveland, O.

"Nichols-Lintern Universal Lanterns" is the title of a booklet recently issued by the Nichols-Lintern Company of Cleveland, Ohio. This booklet contains a complete description of the N-L Industrial Lanterns and Illuminated Signs, rapidly coming into wide use in steel mills, factories and street railway companies.

The well known design of Trent Melting Pots has been extended to include a 45-pound pot controlled by a 3-heat switch, and separable plug connection. This pot has been adapted—not only for label and dipping work, but also for pouring, as a spout and handle are part of the standard design.

The pot has its use wherever the use of Solder, Babbitt, Tin or Lead is melted, and where rapid economical heating and sturdy structure is a necessity.

Harold E. Trent Co., 259-261 North Lawrence Street, Philadelphia, are the distributors.

Helical Gears are described in a leaflet issued by the De Laval Steam Turbine Co., Trenton, N. J. Standard speed motors are less expensive than special motors, and more efficient than slow speed motors. In the case of induction motors they also have a higher power factor. The saving on the cost of a special motor helps pay for the speed converter, while the saving of power due to higher motor efficiency usually exceeds the loss in friction in the speed reducer. This is particularly true if the latter consists of helical gears, which have efficiencies in excess of 98 per cent. Helical gears are used for ratios up to approximately 6 to 1, worm reduction gears being used for larger ratios. They are also used for speeding up, as in driving centrifugal air compressors, centrifugal pumps, homogenizers, small pulverizers, etc. Helical gears are noiseless and smooth-running, as several teeth are at all times in contact.

A very interesting innovation for unloading loose castings from box cars has been recently installed by a large automobile manufacturer. This small crane track is compact enough so that it may be conveniently operated inside a standard box car and it is used for picking up loose castings off the floor of the car by means of a magnet and loading these castings into skid boxes or else bagging them. This device has made the unusual record of unloading a car of loose castings in forty-five minutes while the best previous time was three hours for four men. The cost of operating such a crane truck is approximately the same as the wages paid a laborer so, for the sake of comparison, we get 1.5 man-hours for the crane as against 12 man-hours under the old scheme of hand handling. In other words the addition of this machine speeds up the handling of these castings by 15 times and it is even more efficient on bagged castings.

This equipment was designed and built by the Baker-Raulang Company of Cleveland, Ohio. The crane is known as type S-477 and has a capacity of 1,000 pounds at a 40-inch radius. The truck wheelbase is 40 inches and the tread 30 inches. The driving axle is equipped with 20x3½ tires and the trailing axle with 15x3½. All four wheels steer making the machine very flexible in operation. An automatic cutoff opens the hoist motor circuit when the magnet reaches the top of travel and an automatic interlock, which is controlled by the brake panel, opens the travel motor circuit when the operator leaves the driving platform or releases the foot pedal.

This is a practical safety device as it is impossible to secure power again without first returning the controller to the neutral position. The hoist and magnet controllers are located directly in front of the operator and the hoist may be slowed by means of the conveniently located handles. A lock is provided to retain it in the central position.

The power for operating the travel and hoisting motors as well as the magnet is supplied by a gas-electric unit manufactured by the Ready-Power Company, Detroit, Michigan. This unit consists of a compound-wound ball bearing generator, with a maximum output of 250 amperes at 30 volts, bolted by means of a silent chain to a 4-cylinder Continental engine governed at 1,000 RPM. Engine specifications include pressure feed, three main bearings, helical timing gears, 15.62 horsepower at S. A. E. rating, water cooling with pump circulation and magneto ignition with impulse starter.

The magnet is the 20-inch circular type manufactured by the Ohio Electric and Controller Company of Cleveland, Ohio. The magnet is designed to operate on 1320 watts and is controlled by the switch mounted on the crane which is in turn operated by the controller mounted on the dash next to the hoist controller.

The Ladd Water Tube Boiler Company has announced the appointment of F. P. Fairchild as their Engineering Manager.

Mr. Fairchild was formerly connected with the Dwight P. Robinson Company as a Power Engineer in charge of design on various large steam power developments.

He is a graduate of the mechanical engineering department of the University of Kansas, class of 1910—and is a member of the American Society of Mechanical Engineers.

Announcement has been made by the executive offices of the Graybar Electric Company of the taking of new and larger quarters for its Buffalo, N. Y., branch house. The new branch house at Buffalo is located at 77-79 Swan Street. Former quarters were at 709 Main Street.

The new Buffalo quarters consist of offices and warehouse having 20,000 square feet of floor space, specially constructed to Graybar plans. A complete line of Western Electric products and other electrical supplies are handled.

In discussing the motives actuating the move to a larger building, K. L. Thielscher, Manager of the Buffalo branch, said that the growing importance of that district as a consumer center for electrical goods necessitated a more commodious outlay and a more convenient distributing location. The move, Mr. Thielscher continued, was in conformity with the general policies of the Graybar Company in establishing ever better and larger distributing branches so that the buyer could be given the merchandise where he wants it and when he wants it.

The completion of the huge Conowingo development now being undertaken by The Philadelphia Electric Company, which, when finished, will be the largest hydro-electric installation on the Atlantic Coast and the second largest in North America, was brought another step nearer with the award by Stone & Webster, construction engineers, of several of the giant electrical generators which are to be operated at this plant. The three main generators, which are the largest of their type in the world, in both size and weight, are of the vertical type rated at 40,000 Kv-a. each, and will be furnished by the Westinghouse Electric & Manufacturing Company. In addition this Company was awarded two 1600 Kv-a., vertical water wheel generators and exciters, the total contract amounting to considerable above $1,000,000.00.

The main generators, which will be of the vertical type, will be part of eleven identical units to be installed when the Conowingo Plant is finally completed. The finished installation will be capable of an output of approximately 550,000 electrical horsepower. This will be considerably more than the power output of the Muscle Shoals Plant, now rated as the foremost hydro-electric installation on the Atlantic Seaboard.

The vertical water wheel generators for the Conowingo development will weigh over one and one-quarter million (1,250,000) pounds each. The overall diameter of each machine is approximately 40 feet and the height above the floor line will be approximately twenty-seven feet, indicating the gigantic size of this equipment. Ordinarily all of this type of machinery manufactured by the Westinghouse Company, is produced by the East Pittsburgh shops, but in this instance, part of the equipment will be made at the South Philadelphia Works.

Because it was necessary to include special characteristics to make them particularly stable under vigorous operating conditions, the vertical units are of unusual design. Also these units possess a feature different from the ordinary, in that a small auxiliary generator will be mounted above the thrust bearing of the main generator, its shaft being bolted directly to the main generator and driven from it.

These auxiliary generators are to furnish power for the operation of essential auxiliaries such as pumps, and separate motor generator sets which in turn furnish the excitation for the main 40,000 Kv-a. generators. Directly above the auxiliary generator will be mounted a small direct connected exciter used for exciting the auxiliary generator.

The Conowingo development will supply power to the system of the Philadelphia Electric Company, a distance of about seventy-five miles over two lines of transmission towers, initially each carrying a single three-phase circuit at 220,000 volts. For the ultimate capacity a third circuit will be built.

The Ohio Electric & Controller Co. has issued a leaflet which describes in detail their latest development which is a Push Button Master Switch for the operation of a Magnetic Contactor used in connection with Lifting Magnets.

The development of this control was due to a great many requests for a Master Switch of the Push Button type which could be attached to the throttle of a locomotive crane.

Write P. H. Diver, Manager of Sales, for a copy.

The Monitor Controller Company, Baltimore, Maryland, manufacturers of automatic controllers and electrical resistors has opened a branch office at

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Room No. 417, 136 Federal Street, Boston, Mass., in charge of Mr. Nelson A. McCoy. For the past eight months Mr. McCoy was located at the main office of the company. Previous to joining the Monitor organization Mr. McCoy was with the Wagner Electric Corporation for 15 years. After completing this company's students' course he was made foreman of its motor tests. In 1913 he was transferred to Wagner's Philadelphia sales and service organization and in 1921 was sent abroad covering Hawaii, Australia and New Zealand.

The Westinghouse Company has just manufactured, in record time, and shipped to the Philadelphia Electric Company fourteen steel, safety enclosed, truck type switchboard units for controlling 13,200 volt feeder circuits at the Sesqui-Centennial Exposition. This type of equipment was selected on account of its safety features, the extremely short time permitted for the installation, and on account of the fact that the equipment can be readily transferred to other locations after the Expositon has closed.

The trucks are equipped with manually operated, 600 ampere, type "B-5," 3 pole, multiple single pole oil circuit breakers with current transformer trip coils. On the front panel are mounted an ammeter with current testing switch, and a signal lamp which is lighted through a voltage transformer on the truck when the bus bars are alive and the breaker closed. On the trucks, and also in the housings, the three phases are entirely isolated from each other by means of removable insulating barriers. The secondary wiring is enclosed in iron conduit. The equipment includes automatic shutters, ground contacts between housings and trucks, and complete mechanical interlocking features.

The housings are designed so that they can be used as single units or can be assembled in groups containing two or more housings, according to conditions. The equipment was shipped completely assembled, except for main bus bars and circuit breaker oil, making installation as simple as possible.

The trucks and housings are of exceptionally rugged construction to withstand handling during shipment and subsequent operation, without distortion. All the units are exact duplicates, assuring perfect interchangeability. Truck type switching equipment of same design is also used by the Philadelphia Electric Company on their 13,200 volt distribution system and the equipment now in service at the Exposition will be removed when the Exposition closes and transferred to various points on the system.

A new device for use by the smaller gas companies and for large customer service, where accurate measurement of gas flow is required, has just been brought out by the Cutler-Hammer Manufacturing Company.

It is called the Cutler-Hammer Thomas Meter and is made in sizes capable of measuring from 2,500 cubic feet up to 200,000 cubic feet per hour. The instruments show results in standard units, corrected for pressure and temperature. All corrections for pressure and temperature are made automatically, thereby eliminating mistakes. The instrument panel carries an integrating wattmeter with improved, easy-to-read dials; and a recording wattmeter which gives a graphic continuous record of the rate of flow for each twenty-four-hour period. In customer service, this chart gives an accurate record for setting demand rate. The charts are the usual circular shape and can be conveniently filed with other records.

The instrument panel can be installed any place in the plant where records are most useful. Installation of the instrument panel is a simple matter as no special foundation is required. The meter housing is installed in the existing piping so that no special piping is necessary. The current regulator is incorporated in the instrument panel for convenience. The glass door in this panel facilitates inspection and easy access to all moving parts. Space is provided in the lower part for storage of ink, charts and tools. The work of installation therefore has been greatly simplified.

The new Thomas Meters are made in the following sizes:

For 110 Volt A. C. Service:
- 25,000 cubic feet per hour
- 50,000 cubic feet per hour

For 220 Volt A. C. Service:
- 100,000 cubic feet per hour
- 150,000 cubic feet per hour
- 200,000 cubic feet per hour

These sizes fill practically every need for industrial service. The equipment is extremely simple to wire, to operate and to maintain.

The exceptionally economical Fairmount Pumping Station at Cleveland is described in a pamphlet just issued by the De Laval Steam Turbine Co. of Trenton, N. J. This station contains eight geared turbine driven centrifugal pumps, each delivering from 20 to 75 million gallons per day against heads varying from 86 to 400 feet. The same units also supply large quantities of bled steam at pressures of 3 to 125 pounds per square inch for heating municipal buildings, residences and business blocks as well as the filtration buildings and the pumping station.

Before selecting the type of prime mover to be used, an extensive survey of the economics to be expected from different types of prime movers was made by Mr. L. A. Quayle, Chief Mechanical Engineer of the Department of Public Utilities. The present pamphlet outlines the methods and results of this investigation, describes briefly the type of unit which was finally selected and gives the results of tests made thereon.

As the type of turbine and the method of operation employed at Fairmount are closely similar to those which would be used in any manufacturing plant where low or moderate pressure steam is required for heating or processing, the pamphlet should have general interest.

Bulletin No. 2055, Pittsburgh Transformer Tap Changer, which has just been issued, describes and illustrates very clearly, by means of photographs and drawings, the construction and operation of the Pittsburgh Transformer Tap Changer.

The Pittsburgh Tap Changer is a very simple structure, easy to operate and maintain, yet it is so reliable and dependable that, although thousands have been in service for years,, not a single failure or complaint has occurred with reference to the mechanical and electrical operation.